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— By Keith Reynolds for Planning and Development

UPPER THAMES RIVER

DEPARTMENT OF PLANNING AND DEVELOPMENT

THE HONOURABLE WM. GRIESINGER, Minister

A. H. Richardson, Chief Conservation Engineer

UPPER THAMES VALLEY CONSERVATION REPORT 1952

ONTARIO

TORONTO
1952

Two hundred copies of this report have been prepared, of which this is

Number 123

Honourable William Griesinger, Minister,
Department of Planning and Development,
Parliament Buildings,
Toronto, Ontario.

Honourable Sir:

I take pleasure in transmitting herewith the second Conservation Report on the Upper Thames Valley, being a revised report made after the 1950 survey of the valley, and covering the following sections: Land Use, Forestry, Water, Wildlife and Recreation.

A report on the History of the Upper Thames Valley will be made in a separate volume.

Yours very truly,

A.H. Richardson
Chief Conservation Engineer

Toronto, May 15, 1952

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ACKNOWLEDGEMENTS

While the Upper Thames Valley Conservation Report, 1952, was prepared by the staff of the Conservation Branch of the Department of Planning and Development, University staffs and members of other organizations have contributed generously to the supplying of data.

Thanks are extended to Mr. L.J. Chapman, Research Fellow, Ontario Research Foundation, for the description of climate, and to the Soils Department, Ontario Agricultural College, for the use of their soil maps of Oxford, Middlesex and Perth Counties.

We are grateful to Mr. R. W. Garrett, City Engineer, City of London, for his co-operation in supplying information relative to the flood problem in that city.

For their advice in the preparation of the bird, mammal and fish lists used in the Wildlife Section of this Report, we wish to thank Mr. J.L. Baillie, Mr. Stuart Downing and Dr. W.B. Scott, of the Royal Ontario Museum of Zoology, and Mr. Herbert Milnes of Woodstock. Mr. James F. Gage, Huron District Biologist, also provided valuable assistance and advice in the field surveys.

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Acetate Map of Municipalities (transparency) to be used for locating municipal boundaries, etc., on any page map in the Report

INTRODUCTION

During the spring of 1945 representation was made by a conservation committee of the Upper Thames Watershed to the Honourable Dana Porter, Minister of the Department of Planning and Development, to undertake a conservation survey of that part of the Thames Valley, with special reference to flood control. This request was the culmination of much effort over the preceding years by the citizens of this area, chiefly in the urban centres, who had become alarmed at the tremendous damage which had been done from time to time by excessive run-off in the Thames Valley. This committee realized, however, that the protection of the urban centres from flooding was not the only problem to be considered, but that land use over the whole watershed should be studied and that recommendations should be made for its correction where such was needed.

At that time The Conservation Authorities Act had not been passed, but so urgent was the need for a solution of flooding on the Thames that the newly formed Conservation Branch of the Department of Planning and Development undertook the survey as its initial effort. But in doing so it was clearly pointed out that flood control, while important, would not be the only problem investigated, but also the complementary problems of land use, forestry, wildlife and recreation.

The Second World War was still in progress in 1945; qualified personnel for surveys was limited. Consequently it was necessary to secure the co-operation of science teachers from the collegiates of the Province and due to the limited training of these men in soils and forestry the amount of detail which could be covered was also limited. In the work of hydraulics, however, sufficient competent help was obtained so that the problem of flood control was covered more thoroughly. Land use studies, forestry and stream conditions were confined to a small part of the watershed and

covered only the watersheds of the Cold Creek and North Branch Creek. But while it was realized that this coverage was inadequate, it was all that could be done under the circumstances, and the results of these studies as presented in the report were considered only as a token survey to indicate what the conditions in these three fields were over the whole area. However, these token surveys, together with the work in hydraulics, indicated to the people of the Upper Thames how the whole pattern of conservation is inseparably related.

The report which was based on the 1945 survey was presented to the Upper Thames Committee at London in October 1946 by the Honourable Dana Porter, Minister of Planning and Development at that time. The enthusiasm with which this report was received and the action taken on its recommendations cannot be enlarged upon here. Nevertheless it should be stated that the Upper Thames Authority now is the most active group of its kind in the Province. Besides many activities in general conservation, the construction of the Ingersoll Channel and the commencement of the Fanshawe Dam, as well as the reforestation agreement with the Government, all stem from recommendations contained in the 1946 report.

After the war, and when students from the different science faculties of the universities were available, the whole technique of land use, forestry, and wildlife surveys was changed and improved and this changed procedure has been followed in surveys conducted by the Conservation Branch since that time.

In the spring of 1950 the Upper Thames River Conservation Authority requested the Honourable William Griesinger, Minister of Planning and Development, to resurvey the Upper Thames Watershed in accordance with the improved methods adopted by the Conservation Branch and that

this information be set down in report form comparable to the reports being prepared for other Authorities. This survey was carried out in the summer of 1950 and the results are embodied in the present report.

Certain sections of the old report - chiefly history, land settlement, recreation and the history of floods - have been repeated in the 1952 edition. These, however, have been revised and brought up to date where necessary. The sections on land use, forestry, stream conditions and, to a certain extent, hydraulics are for the most part new material.

The 1946 Thames Report was typewritten, which limited its edition to only eight copies, whereas 200 copies of the present report have been mimeographed. In addition, 3,000 copies of a summary with selected maps and many illustrations will be printed. The full report is intended as a working plan, chiefly for the guidance of the members of the Authority and other officials, while the summary is an abridgement of this for general distribution throughout the watershed.

Lastly, as the present report is printed on one side only of mimeograph paper for the sake of clarity, which increases the size, it has been decided to publish it in two volumes. The first will include land, forestry, water, wildlife and recreation, and the second will cover only History.

- A. H. R.

RECOMMENDATIONS

RECOMMENDATIONS

STATED OR IMPLIED IN THIS REPORT

Land Use

1. That plans and demonstrations of soil conservation be carried out according to the farm regions outlined in this report (Chapter 6). pp. 45, 51

2. That the Authority gain control of land use on one or more farms to demonstrate special methods of soil and water conservation. p.50

3. That the Authority co-operate in establishing demonstrations on farms to show methods of controlling soil erosion and accelerated run-off and sponsor a field day to illustrate use of tillage machinery in erosion control methods, as was done at the International Ploughing Match, 1951. pp. 50, 54

4. That the Authority give leadership in establishing soil and water conservation practices, particularly in areas which drain into flood control works, to cut down loss of flood storage by sedimentation. p.51

5. That the Authority make special equipment and technical advice available to farmers for gully stopping, grassed waterways, diversion terraces and farm ponds. p. 53

6. That grassland farming, including pasture improvement and use of grass silage, be considered the most important single soil conservation measure to be applied on the watershed, and support given to Crop Improvement Associations carrying on this work. p. 55

7. That the Authority, through one of its advisory boards, watch closely, and influence when it can, land drainage schemes. p. 57

8. That the Authority call together representatives of all businesses concerned with land use to discuss plans for soil and water conservation. p. 58

9. That the Authority make available the resources inventory and plans contained in this report to all business firms in the watershed which have an interest in the productivity of the land. p. 59

10. That the Authority explore the possibility of ensuring soil-building practices on rented farms by means of covenants in leases. p. 60

11. That the Authority continue its aid in establishing farm ponds and that demonstrations of various types be sited according to the regions set forth in this report in which they are particularly suitable. p. 63

Forestry

12. That the Thames Forest be extended to embrace approximately 18,600 acres contained in 15 tracts throughout the watershed. At the time the report was written, 1,951 acres had been acquired; during the summer of 1951 approximately 500 additional acres were purchased, making 2,450 acres in all. It is recommended that this be expanded as rapidly as possible by a definite program of annual additions. p. 43 and map p. 42

13. That other marginal land in smaller isolated blocks be watched by the Authority and acquired, as it becomes available, either by the Authority or by municipalities, to increase their existing woodlands or establish new areas. p. 50 and map p. 42

14. That the Authority expropriate all land suitable for conservation purposes, subject to the regulations of The Municipal Act, as and when such lands become tax delinquent. p. 67

15. That the Authority set up a committee to determine the best method of providing fire protection through the co-operation of the Department of Lands and Forests for such areas as the Ellice and Gads Hill Swamps. p. 56

16. That the Authority encourage the establishment of natural regeneration in and close to existing woodlands by instructing landowners in methods of scarifying soil and breaking sod immediately preceding the dispersal of seed by parent trees. This should be done in early September for most species but in early June for the elms and soft maples. p. 52

17. That the Authority inaugurate a scheme to aid farmers in fencing their woodlots from cattle. This would enable natural regeneration to establish itself, restore the spongy cover of leaves and humus over the soil and improve the water-holding capacity of the soil itself. p. 54

18. That reforestation of marginal, privately owned land be encouraged by the Authority. It is recommended that in addition to providing tree-planting machines the Reforestation Advisory Board provide a crew of trained tree-planters which will be available throughout the tree-planting season to landowners whose property is too steep, bouldery or wet for the operation of machines. p. 32

19. That the Authority purchase a portable wood chipper, which would be made available to farmers in the same way as the tree-planter. This could be used to clean up low-grade hardwood and weed trees in woodlots. The chips can be used in place of straw for cattle bedding and chicken litter and returned to the fields as humus. In some cases it may be possible to sell such chips to pulp and paper companies. p. 103

20. That the Authority support the Provincial School Forestry Competition and 4-H (formerly Boys' and Girls') Forestry Clubs by enlisting the help of co-operators, providing transportation where necessary and special recognition of winners. p. 41

21. That the Authority request the Department of Lands and Forests to require all log buyers who purchase logs from Southern Ontario woodlots to publish their log-grade specifications, together with prices offered. pp. 103-106

22. That the Authority set up a committee to publicize the following among woodlot owners and sawmillers, where necessary:

    (a) The advantages of replacing the present system of custom sawing by an arrangement whereby credit is given for "custom logs", and against this credit the farmer receives, at preferred prices, the species, quantity and quality of product best suited to his needs. p. 92

    (b) Lists of buyers who are interested in the purchase of woodlot products. These may be obtained from the Zone Forester. p. 106

    (c) The advantages of soliciting tenders from as many buyers as possible who are within economic operating distance of the woodlot. p. 93

    (d) The advantages and disadvantages of lump-sum sale and stumpage-rate sale. pp. 93-99

    (e) The benefit of having a written Timber Sales Contract for timber on the stump. It is recommended that the Advisory Board, in co-operation with the Zone Forester, prepare a suggested form of contract. pp. 114-115

    (f) The arguments in favour of having experienced loggers do the cutting and the owner handle small products, such as fuelwood, posts and bolts. p. 99

    (g) That the marking of trees for removal is a technical operation vital to the future of the woodlot, and that it should only be done by the Zone Forester or other trained personnel. p. 114

    (h) The importance of having the woodlot appraised prior to selling the farm. pp 94-95

23. That the Authority make direct representation to the Department of Finance of the Federal Government in support of the recommendation in the Report of the Select Committee on Conservation (1950) that "the Dominion Government should be asked to consider amending the Dominion War Tax Act so that landowners will no longer be penalized for cropping their timber in accordance with conservation practices".

24. That the Authority use its influence to have assessment revised so that land only is assessed, not the timber growing on it, and that the municipality concerned recover its revenue by means of a severance tax imposed at the time the timber is cut.

Water

25. That measures be taken immediately to control and check any further encroachments on the river. p. 8

26. That the Authority consider the engaging of technical help and equipment to make B.O.D. tests and bacterial counts along the river and its tributaries. p. 55

27. That the installation of efficient secondary waste treatment devices at those plants shown on the Pollution Map (p. 53) as lacking satisfactory treatment facilities be instigated. p. 57

28. That a Water Pollution Control Board be established. p. 59

29. That a classification of waters for particular uses be adopted. p. 59

30. That a set of standards for quality and purity be established to apply to these classified waters. p. 59

31. That the legality of the Authority instituting a permit system to control all new outlets into the river and its tributaries be investigated, and if within the jurisdiction of the Authority that such a system be commenced. p. 59

32. That the Forestry and Land Use recommendations be implemented to promote deep seepage and augment the ground water resources. p. 74

33. That a system of reservoirs be provided in conjunction with some diking and channel improvement, for protection against spring floods one-and-one-third times greater than the greatest flood on record, viz. the 1937 flood on the South Branch combined with the 1947 flood on the North Branch. p. 83

34. That the following dams and reservoirs be constructed as soon as funds are available:

(a)	Fanshawe (under construction)	$4,711,250
(b)	Glengowan	2,020,000
(c)	Wildwood	1,407,000
(d)	Thamesford	2,440,000
(e)	Woodstock	760,000
(f)	Cedar Creek	604,000
p. 86		$11,942,250

35. That all of the reservoirs (except Fanshawe) be filled to the conservation level during the spring run-off period and the stored water be used to increase and sustain subsequent low flows. p. 85

36. That the Fanshawe reservoir serve as a recreational lake for the community and a domestic water supply for the city of London. p. 87

37. That in order to provide some immediately localized flood protection, channel improvement schemes be carried out at the following places:

(a)	Ingersoll (now completed)	$1,000,000
(b)	St. Marys	135,900
(c)	Mitchell (including a small dam)	260,000
(d)	Woodstock	75,000
		$1,470,900

p. 93

38. That land required for reservoir sites be purchased or leased as soon as possible, particularly those close to urban municipalities which might be built upon. p. 91

39. That snow survey stations be established at strategic points on the watershed, the condition of the ground observed and the depth and water content of the snow measured from time to time in order that an anticipated estimate may be made of the amount of spring run-off due to snow melt and rain. p. 114

40. That as the dams come into operation, the control organization be expanded and equipped; and that the system of communication between the control centres and the dams, trouble areas, gauges, snow survey stations and meteorological stations be such that there will be a rapid assembly of all reports to the control centre and instructions rapidly issued therefrom. p. 116

41. That a program of restoration of old small mill dams be inaugurated throughout the watershed. p. 127

42. That the Authority investigate any drainage scheme which is proposed within its boundaries and have a representative present at the presentation of the engineer's report, as provided by The Municipal Drainage Act. p. 126

Wildlife

43. That the Authority encourage farmers to improve their land for wildlife by the elimination of grazing of woodlots, by selective cutting in woodlots, by improved cultivation practices and by the planting of wildlife food patches. pp. 13-15

44. That the state and trend of meadow mouse populations be examined in areas scheduled for reforestation in the fall of the year of planting, and regularly each fall for at least five years thereafter; and that research be carried

out to discover adequate repellent sprays for the protection of orchard and forest trees from the meadow mouse and the European hare. pp. 22, 27

45. That the introduction of fish into the watershed be restricted to those parts of the river shown on the map "Biological Conditions of Streams" to be suitable for the species concerned. p. 32

46. That the fishing in the watershed be improved by the following methods:

    (a) Encouragement of owners of spring creeks to extend the range and abundance of speckled trout by planting alders or willows along the stream banks, by installing small dams and deflectors and by constructing trout ponds near the sources. pp. 39, 40

    (b) Encouragement of farmers to construct and maintain warm water ponds for the production of fish. p. 41

47. That the Fanshawe Dam Advisory Board on Drainage and Pollution be charged with setting up a five- or ten-year program of pollution abatement, to be reviewed at regular intervals as the program progresses. p. 34

48. That the Authority urge the Provincial Department of Health to apply strictly the provisions of the Public Health Act relating to the control and prevention of stream pollution, with particular reference to the 14 milk products factories which do not appear to have adequate septic tanks and field-tile beds. p. 34

49. That the Authority present an annual award or citation to the sportsmen's club which by its actions in a given year best promotes wildlife conservation and improved farmer-sportsman relations.

Recreation

50. That 2,226 acres, including the proposed Fanshawe Dam site and the banks of the North Branch of the Thames as shown on the Thames Valley map, be acquired and administered by the Authority as a Multiple Use Recreation Area. p.9

51. That the following facilities be provided by the Authority in the proposed Thames Valley Park:

(a)	Boating and fishing on a permanent lake	p. 11
(b)	Aquatic sports facilities	p. 11
(c)	Wading beaches for children	p. 11
(d)	Scenic drives with pullouts	p. 11
(e)	Picnic sites	p.
(f)	Group and individual camping areas	p. 12
(g)	Nature trails	p. 12
(h)	An arboretum	p. 12
(i)	Ski trails	p. 12
(j)	An outdoor theatre	p. 13
(k)	Demonstrations of reforestation, well-managed woodlots and erosion control	p. 13

52. That the Authority urge the Canadian Youth Hostels Associations to establish one or more Youth Hostels in the neighbourhood of Thorndale or Plover Mills. p. 13

53. That a long-range plan be carried out for the acquisition for the public of 22 small picnic sites scattered throughout the watershed. At these sites parking space off the roads would be provided and tables would be set up. p. 14

54. That some of the better swimming holes be improved by the installation of diving boards and some indication of the depth of water. p. 18

55. That one of the following three areas be acquired by the Authority and retained as an unspoiled wilderness area:

Part of Lots 18-21,	Con. IV,	Oxford Township
Part of Lot 15,	Con. XI,	Zorra East Township
Part of Lot 24,	Con. XIII,	Nissouri East Township

p. 19

56. That a small area be acquired as a historic site at the site of the Byron Mill. p. 20

57. That a marker be installed near Woodstock at the site of the western end of the Indian trail from the head of Lake Ontario to the Thames River. p. 20

58. That the Authority stimulate the growing public interest in conservation by establishing a Conservation Trail in the watershed. Permanent markers, visible from the road, would point out good examples of sound conservation methods in use. The trail should also include the results of misuse of land, but here markers would be set up only if the farm was abandoned. Maps of the route would be distributed to students or visitors taking part in it. The route would be a circle and should include several attractive picnic sites to provide suitable areas for lunch. p. 20

LAND

CHAPTER A

GEOLOGY, PHYSIOGRAPHY AND CLIMATE

1. Bedrock Geology*

Although the bedrock is covered by a mantle of softer materials to a depth of 100 feet or more over much of the area, and as deep as 230 feet in some parts, it is important in a number of ways. First, it determines to a great extent the altitude and slope of the country. Second, the materials on which the soils have developed are derived mostly from the bedrock underlying the country. Third, the rock is exposed or is very near the surface in certain localities, as at St. Marys and at Ingersoll, and is quarried for various purposes. Lastly, the control of the river by engineering works requires, in some instances, solid foundations which can be found only on bedrock and, fortunately, this is possible in certain selected sites.

The backbone of the continent, the ancient pre-cambrian rocks, lies under 2,800 to 3,400 feet of sedimentary rocks, sandstone, shale and limestone. The pre-cambrian basement has an average dip of 28 feet a mile to the south-west. The sedimentary rocks have a surface with a slightly less dip. It is this rise from the south-west towards the dome in Dufferin and Grey Counties which predetermines the drainage pattern.

The sedimentary rocks underlying the soft materials are mostly shale and limestone. The soil materials are therefore clayey, derived from the shale, and are quite limy.

Along the valley bottoms the soft material is not so deep as in the surrounding countryside, and in building the Fanshawe Dam a rock base was available at 23 feet. Other proposed sites have bedrock at even less depths. Within the

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* Caley, J.F. Palaeozoic Geology of the London Area, Ontario. Geological Survey of Canada, Memoir 237, 1943; and Palaeozoic Geology of the Brantford Area, Ontario. Geological Survey of Canada, Memoir 226, 1941.

BEDROCK GEOLOGY

LEGEND

PALAEOZOIC

DEVONIAN		
HAMILTON FORMATION		Soft blue and gray shale and gray limestone.
NORFOLK FORMATION		Gray and brown limestone and magnesium limestone, calcareous sandstone, chert, small quantities of gypsum.
SILURIAN		
BERTIE AKRON SERIES		Buff and brown dolomitic limestone and dolomite.

underlying limestone, dolomite and shale and other deposits are levels containing water, gas, sulphur compounds and salt. Supplies of water from the rocks are not always of use because of these impurities.

The sedimentary rocks are among the oldest of this type of rock, called the Palaeozoic. The uppermost formations are of the Bertie-Akron of the Silurian system and the Norfolk and Hamilton of the Devonian system. The distribution of these formations is indicated in the accompanying maps.

2. Physiography

The soft material mentioned above as covering the bedrock is the result of the action of vast masses of ice, the Continental glaciation of 20 or 30 thousand years ago. The material, called "drift", was accumulated from the rock of the continent and deposited during at least three advances of the glacier. The kind of the lower deposits made by earlier glaciations, or by bodies of water between glaciations, determines to a great extent the nature of deep ground-water supplies, but little is known about them in detail. The last glaciation moulded the landscape as it is now seen and provided the material on which the soils developed. It is from the most recent deposits that shallow ground-water supplies are obtained.

The surface deposits were made by the advancing ice sheet, at its face or under its edge as the ice body decomposed or by streams and bodies of water created by melting ice. The surface has been eroded by the streams of the present river system, but in general the topography is more or less that which was moulded by the glacier and post-glacial waters. The present drainage system conforms pretty well to the relief rather than being the cause of it, as in unglaciated territory.

The upland called "Ontario Island" by Taylor* was the first part of Ontario freed of ice in the retreat of the Wisconsin glacier. The ice mass surrounding this "island"

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* Taylor, F.B. The Moraine Systems of Southwestern Ontario. Trans. C.I. 1913.

gradually assumed the form of two lobes that separated in their recession in the vicinity of London. Meltwater from the glacier poured onto the upland from the higher ice around it and found an escape in the crease to the south between the retreating lobes. There was built up in this way a number of drainage outlets or spillways which formed troughs in the till. These are occupied in part at the present time by the Thames River and its tributaries and are usually gravel-terraced valleys, much broader than would be warranted by existing drainage.

Another important glacial feature associated with the retreat of the ice lobes was the formation of terminal moraines which were flanked in some cases and separated in others by the drainage outlets. The moraines may be classified as either till or kame, depending on whether they were laid down on land or under water conditions.

The till moraines are composed chiefly of unsorted glacial materials and were formed at halts in the advances or retreats of the ice front. There are two more or less continuous till moraines, one in the south part and one extending irregularly across the north-west part of the watershed. The southern moraine lies immediately to the south of the Thames River between London and Ingersoll. At Ingersoll it swings away in a semicircle to the south-east and returns to the vicinity of the Thames River east of Woodstock. It is irregular in outline and broken in places by drainage channels. Its relief is usually between 25 and 50 feet above the adjacent land.

The northern till moraine enters the watershed from the west at Elginfield, extends in a north-easterly direction to St. Marys, turns almost due north as far as Fullarton and passes out of the watershed to the north-east, midway between Mitchell and Stratford. Taylor describes this moraine

as "a slender lightly built moraine rather narrow but quite well defined, its relief being generally 20 to 30 feet, sometimes 50 feet".

There are two kame deposits of minor size within the watershed, one at Cobble Hill and the other a few miles east of St. Marys. A much larger kame moraine occurs east of Stratford but most of it lies outside the watershed.* Swampy areas in the hollows of the kame hills are the sources of the Avon and other tributaries of the Thames River. Gravel pits are often located in these hills because of the more or less sorted nature of their sands and gravels.

The moraines were formed by halts in the ice movement. The land form created under the ice while it was moving is called a till plain. Two types are found. In the south-easterly areas the till has been moulded into long oval hills called drumlins or whalebacks or into ridges and flutings. The drumlins and ridges run in a north-west to south-east direction. The till is made up of a medium-textured loamy material.

In the north-westerly half of the watershed the till plain has not the definite ridging of the drumlinized topography. Some of the till is of a heavier texture. These two characterisitcs, a "tumbled" or irregular topography and a heavier soil, restrict the drainage both overland and within the soil.

The land forms created by glaciation are shown on the accompanying map. In addition to the moraines, the two kinds of till plain, the meltwater channels (or spillways) and the kame moraines described in the preceding paragraphs, there are also recorded on the map eskers, sand plains and areas of muck.

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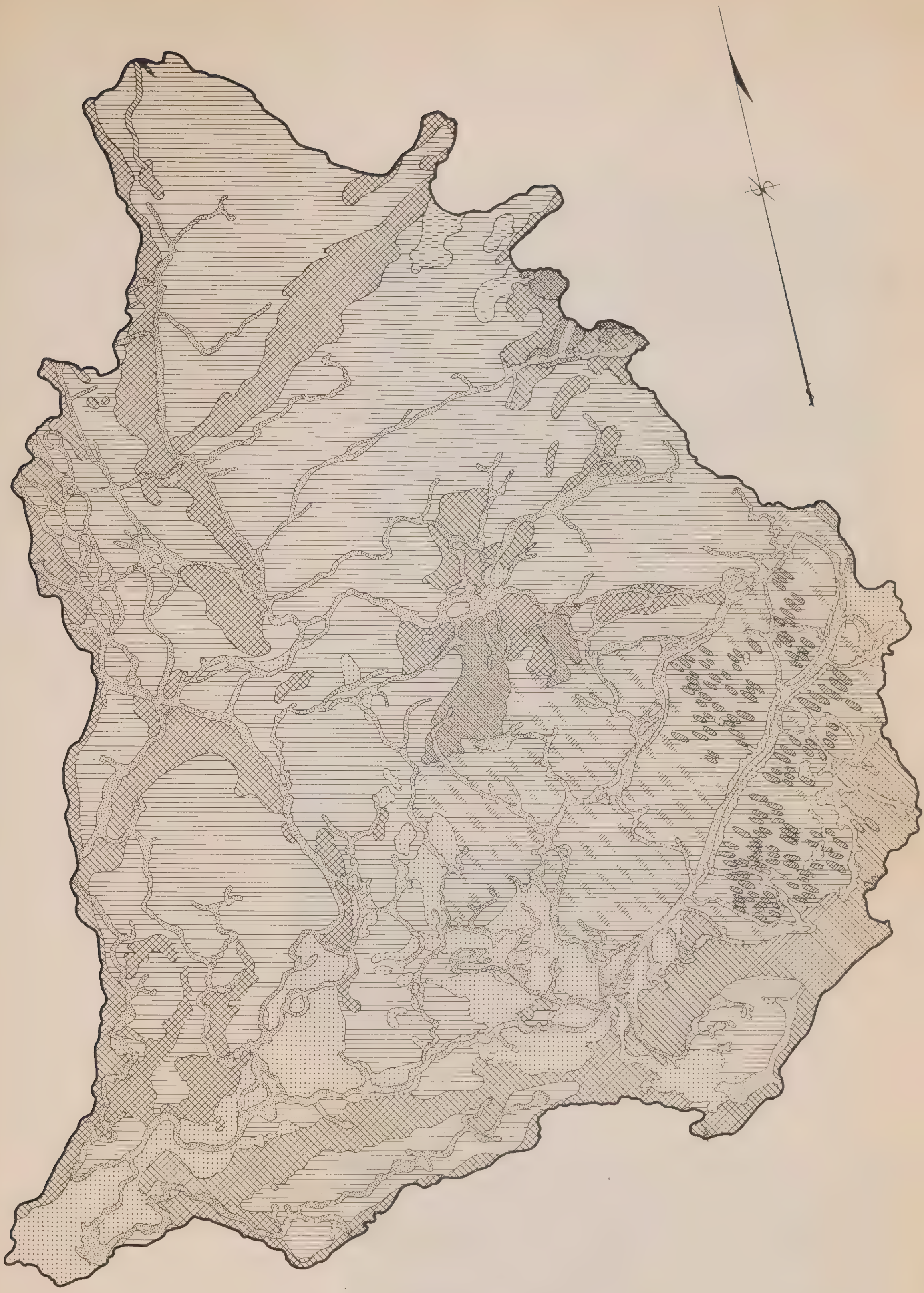
* Chapman, L.J. and Putnam, D.F. The Physiography of South-western Ontario. Scientific Agriculture, 24:3, 1943.



PHYSIOGRAPHY

LEGEND

- TILL PLAIN DRUMLINIZED
- TILL PLAIN UNDRUMLINIZED
- DRUMLINS
- SPILLWAYS
- SAND PLAINS AND DELTAS
- KAME MORAINES
- ESKERS
- TILL MORAINES
- MUCK

SCALE : MILES

1 0 1 2 3 4 5 6 7

The limestone bedrock which underlies the watershed determines the overall structure of the country and the nature of the soils. Quarry near Beachville.

The eastern portion of the watershed has many gentle ridges running north-west to south-east as in this scene south-east of Ingersoll.

Much of the watershed is flat but broken by irregularly hummocky slopes like this moraine south of London.

Eskers are ridges of gravel which cross the plains like rivers and are made up of roughly stratified sand and gravel like the kame moraines. Around London there are broad sand and gravel plains. These are the remains of deltas and off-shore sand deposits in post-glacial bodies of water. Muck deposits were formed in river valley bottoms and in upland areas of poor drainage by the accumulation of decayed vegetation.

3. Climate

The peninsular part of Southern Ontario is an upland which rises over 1,000 feet above the Great Lakes. The Upper Thames drains part of the south-western slope of that upland and its climate is affected by this position; particularly the rainfall and snowfall are above the average for Southern Ontario. On account of the special interest in floods and running water in this area, special stress will be given to these factors.

Three weather stations of long standing provide a reliable set of records on which to base a description of the local climate. They are at London, Stratford and Woodstock, strategically situated so far as the Upper Thames is concerned.

The winter temperatures on the Upper Thames are like those in the Toronto area or in Huron and Bruce Counties. In January, or in the three coldest months, Stratford is two degrees colder than London, which is a very definite difference. The snow blanket will be deeper at Stratford for this reason. In mid-summer the temperature spread is only slightly less. London and Woodstock have the same temperature in July as Kingston and Ottawa. The lowest temperatures officially recorded are -27°F. at London, -28°F. at Woodstock, -31°F. at Stratford and -32°F. at Lucan. Plant growth generally begins at London about the second week in April on the average, while the season is nearly a week later at Stratford. Killing frosts

may be expected in five out of every ten years for a month later, that is, until May 13 at London and May 15 at Stratford, according to the figures.

The yearly precipitation averages 38 inches at London and Stratford, which is approximately 5 inches above the average for Southern Ontario. At least half of this is extra snow. Woodstock, with 33 inches in all and 58 inches of snow, is near the average for Southern Ontario. The rainfall of the summer six months is 19 inches at Stratford, 18 inches at London and 17.5 inches at Woodstock. London and Stratford are in line with the heavy snow belt that extends across the westerly slope south of Georgian Bay. In short, the Upper Thames Basin is in one of the wetter parts of the Province, comparable to the most easterly counties in the St. Lawrence and Ottawa lowland.

When considering floods or soil erosion the occurrence of unusual downpours or extended rains deserves special attention. It has been pointed out that run-off is at a maximum when the soil is saturated or the surface is glazed over with ice. Moreover, a heavy rain coinciding with a sudden warm spell in springtime adds meltwater from accumulated snow. For these reasons, the amount of rain needed to produce a flood cannot be stated definitely. The great flood of April 24 - 26, 1937, resulted from a widespread rain of four to over five inches in 48 hours falling on an icy surface, but no doubt serious floods are produced by lesser falls.

In order to get some figures on the frequency of heavy rains, the daily records taken at London, Stratford and Woodstock were examined for the last 25 years, that is, from 1921 to 1945. Disregarding rains of less than 1 inch during a 48-hour period, the accompanying table gives the number of 1 to 2, 2 to 3 and 3 to 4 inches or more at these three stations. Only the period of March 1 to October 31 was considered. Precipitation falling as snow was ruled out.

The first point of interest is that heavy rains are much less frequent during March and April than in the summer months. This is very fortunate; if the situation were reversed the spring floods would be much more frequent than they are now.

Judging by the past 25 years (1921 - 1945), falls of over three inches within 48 hours may be expected in one year out of five at London and Woodstock, and once every two or three years at Stratford. If several days of steady rain falling at a rate of less than three inches in 48 hours will produce bad floods on the Thames, then the totals just given do not represent all the flood-producers.

The question of whether the rains of the past 25 years can be taken as a measure of normal conditions may well be asked, because we are interested in predicting for the future. While it does not settle the question, the Stratford records for the period of 1896 to 1920 were examined for comparison with the succeeding 25-year period. The number of rains of over one inch in 48 hours was nearly the same in two periods - actually 156 in the earlier and 163 in the later period.

Westerly wind having a speed of seven to ten miles per hour is a typical trait of the climate in south-western Ontario and the London, Woodstock and Stratford stations all agree on this point. South-westerly or north-westerly winds are nearly as frequent as those which blow directly from the west. Sometimes strong winds and hail go together; such storms come along in about two years out of three. Twisters like the one that caused so much damage to buildings on the northern outskirts of Strathroy as recently as August 1944, fortunately, are only occasional visitors.

Bright sunshine for the area is recorded only at Woodstock. The sun shines approximately half the time possible during the growing season (April 1 - September 30), which is a little less than in drier parts of the Province.

THE FREQUENCY OF HEAVY RAINS (1921 - 1945)

Station	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
1 - 1.99 inches in 48 hours									
LONDON	3	13	21	21	18	17	19	19	131
STRATFORD	7	16	14	20	16	19	12	18	122
WOODSTOCK	3	10	16	18	20	16	20	13	116
2 - 2.99 inches in 48 hours									
LONDON			5	4	4	6	4	5	28
STRATFORD			7	8	7	4	4		30
WOODSTOCK	1	1	5	3	6	1	5	1	22
3 - 3.99 inches in 48 hours									
LONDON			1	1	1	1			4
STRATFORD			2	1	1	3	3		10
WOODSTOCK		1		1	1				3
4 inches and over in 48 hours									
LONDON					1				1
STRATFORD				1			1		2
WOODSTOCK		1			1				2

THE FREQUENCY OF HEAVY RAINS
AT STRATFORD 1896 - 1920

Amount in 48 hours (inches)	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
1 - 1.99	6	8	20	22	21	20	17	17	131
2 - 2.99	1	3	1	-	3	4	5	3	20
3 - 3.99	1								1
4 - up					2		1	1	4

CHAPTER 1

PURPOSE AND METHODS OF THE SURVEY

1. Statement of Purpose

The purpose of a soil conservation survey is fourfold: to make an inventory of the physical conditions; to make an inventory of land use; to appraise the capabilities of the soil and estimate the adjustment of use to capabilities; and to recommend that use of all the land which will sustain the resources of soil and moisture for all time.

2. Inventory of Soils

The first step in achieving the purpose of the survey is to identify, map and describe the soil types, to determine those features which limit the use and to measure the degree to which these features affect land use.

3. Inventory of Land Use

The use to which land is actually being put must be known. It is the best indication of the quality of the land. Present use indicates the type of agriculture being practised and the use must be known before a program can be drawn up which might cause changes in use.

4. Appraisal of Capabilities

A comparative rating of the capability of soil is indicated by the intensity of use of each kind of soil. Further consideration is given to the findings of tests and experiments made on the various soils or natural conditions. When all the land is divided according to capabilities and the present use is recorded on a map, direct comparison shows to what extent the various uses are adjusted to the capability; for example, how much of the land of highest capability is under intensive cultivation and how much of the land of lowest capability is retained under forest cover.

5. <u>A Soil Conservation Program</u>

To carry out a soil conservation program requires that each piece of land is used according to its capability. This means that the best land be used to the full extent of its ability to produce and the poorer land used only for that purpose which will yield consistently well without the land deteriorating in any way.

Further to making the actual type of use (cultivation, pasture and so on) fit the land, there must be special practices followed to make the best use of the land; either to take advantage of its fertility or moisture or to check destructive processes. These include soil-building practices, liming, fertilizing and crop rotations, erosion control measures such as contour cultivation, strip-cropping, grassed watercourses and diversion terraces and the improvement of wet lands with high fertility by artificial drainage.

A soil conservation program is not one which can be carried out in a short time or by a few people. It involves all those who own the land, and might take a generation to carry out. A plan or map of recommended use is really a guide to the adjustment of land use and management to the natural characteristics of the land.

6. <u>Special Projects</u>

Holding surface run-off in ponds for farm use is a conservation measure of special interest. To find out as much as possible about such ponds a survey was made of all existing ponds on the watershed.

A recognized method of getting a conservation program started is to set up a demonstration project. This is particularly suitable on the watershed of a small river when the results of conservation work can be seen in the behaviour of the stream. The drainage area, or watershed, of the Avon River above Stratford was studied in detail for the purpose of establishing a pilot project incorporating as many conservation practices as possible.

7. Survey Methods, Reconnaissance Mapping

The soils and land use of the watershed were mapped on a "reconnaissance" scale. That is, the area was travelled by car and visited on foot where vehicles could not drive. An area of 50 acres was set as the minimum of any soil type or condition which could be mapped. Land use was recorded, field by field, in a simple classification. Although aerial photographs with a scale of 5.28 inches to the mile were used to interpret the landscape, the mapping was done on the topographic sheets with a scale of one inch to the mile.

8. Existing Soil Maps and Other Information

While the area was being surveyed, use was made of all reports and maps already in existence. County soil maps were available for Middlesex and Oxford Counties and the soil mapping of Perth County was made available by the Ontario Soil Survey. Geologic maps of Western Ontario were used. Also, reference was made to maps of glacial geology made available by the Ontario Research Foundation.

A previous, detailed study made of erosion and land use capability in 1945 formed the basis of the classification used in the field. Conservation surveys on adjacent areas also contributed to a knowledge of the capabilities of soil types on the watershed.

9. Men and Equipment

The soil conservation survey field work was done by students and graduates in Agriculture and Geography from Ontario Universities. They travelled in pairs throughout the area in jeeps. Their equipment included tiling spades to open up the soil for examination, soil augers to bring up soil samples from depths of three and a half feet, and bottles of dilute hydrochloric acid for a simple chemical test to determine the depth of the soil.

10. Technical Equipment

Aerial photographs on the scale of 1,000 feet to the inch (5.28 inches to the mile) provide base maps on which are recorded all data found by field work. Interpretation of aerial photographs is a method of determining types of land and soil and particularly in establishing the extent and boundaries of any type recognized on the ground. They also provide an accurate map of forest cover, built-up areas and the shape and size of fields.

Abney hand levels are instruments for measuring slopes. These are used to determine the slope of land in estimating erosion conditions. This is an essential part of a conservation survey.

11. Preparation of Maps

The field observations are plotted on aerial photographs. These are traced onto sheets and photostated copies made on the scale of one inch to the mile. The mapping is then traced onto one map of the watershed on the one-inch scale. In printing for publication the scale is further reduced but the original accuracy and detail of the large scale is retained.

CHAPTER 2

SOILS OF THE WATERSHED

1. Definition of Soil

The most generally held idea of soil is that of the mantle of the surface of the earth in which seeds germinate and plants grow. The agricultural use of soil depends on the value of the soil as a medium in which seeds germinate and plants can grow, drawing moisture and nutrients from the soil.

Soil is a natural body formed from the mineral crust of the earth by living things on and within it by the action of air and water. The soil has its own characteristics which sum up the effects of its mineral and organic origin and the forces of weather and life which produce it.

Types of soil are recognized and defined by the various levels or horizons which are revealed in a vertical section or profile. There are three main horizons, the topsoil, the subsoil and the parent material. The topsoil is that which contains the organic matter, shows the greatest effect from weathering and the forces of decay and provides the best medium for plant growth. The subsoil has little or no organic content, but shows the results of the weathering action which has produced the soil. The parent material is entirely of mineral origin, shows little sign of weathering and no effect of life except where roots may have penetrated it.

2. The Great Soil Groups

The soils of the world differ chiefly in the effect of climate. Corresponding to climatic differences over the face of the earth there are major differences in soils. For example, the soils of Ontario, in a cool, moist climate, differ greatly from those of Western Canada with a cool dry climate and those of the Southern United States with a moist warm climate. Each of these areas is included in one

of the "great soil groups". Most of the soils of Southern Ontario belong to the group known as the "gray-brown podzolic soils" or "gray-brown forest soils".

The chief weathering effects in the area of gray-brown podzolic soils are those of the surplus of moisture which falls during the greater part of the year, and the acid products of decomposition of trees, leaves and herbs.

Before the land was cleared for farming the natural cover was forest. The decay of leaves and wood produce a top layer of organic matter, or humus, with an acid reaction. The surplus water of rain and snowfall dissolved the acids and the solution percolated downwards through the soil. The acids leach certain minerals, particularly the calcium and iron compounds and the finest (colloidal) particles from the soil below. The iron compounds and colloids are redeposited at a lower level and free lime and magnesium carbonates at the lowest levels of the weathered material.

A vertical cross-section of the soil, or profile, reveals a number of levels or "horizons" with distinct characteristics. In the horizon at the surface the decayed plants are incorporated with mineral material to make a dark-coloured soil. Immediately below this is a very light-coloured horizon with no organic matter, quite powdery and loose. The surplus moisture of the rainfall and the acids from the top horizon have leached the light-coloured horizon. The dark and light-coloured horizons constitute the top soil. The subsoil is brown or reddish-brown in colour and has accumulated in it much of the materials leached out of the topsoil. Below the "subsoil" is the parent material. This is of entirely mineral composition and shows little or no effect of weathering.

The horizons, and their characteristics, of a typical gray-brown forest soil are illustrated in the accompanying illustration.

In an undisturbed virgin soil in a forest area the top horizon is of purely organic material, the result of decay of leaves, and often called "leaf mould". This horizon is labelled the Ao. In land which has been cultivated the Ao horizon has disappeared or mixed in with the lower A1 horizon. The A1 is the familiar dark, loamy topsoil of an uneroded soil. It is the A1 horizon in a virgin soil or a cultivated soil kept in good tilth that offers the best medium for the germination of seeds and the growth of grasses, cereals, roots and many legumes. It is the A1 horizon which most readily absorbs the rain and makes moisture available to plants. The chemical nature of the soil in this horizon and the activity of microscopic plants in it make plant food most readily available to crops. The loss of the topsoil by erosion or the loss of its tilth or fertility under mismanagement seriously reduces the value of the soil.

Underneath the dark-coloured topsoil is a light-coloured, dusty horizon. It is labelled the A2. From this horizon the lime, the iron and the fine clay and other colloidal particles have been leached. It is acid in reaction, has less plant nutrients and no well defined structure. In cultivated soils, some of this horizon becomes mixed with the A1. Usually, however, in an exposed vertical section of soil the light-coloured band shows up quite clearly.

The subsoil is called the B horizon. In it are accumulated some of the mineral nutrients, the fine particles and the iron compounds which have been washed from the topsoil. It is the presence of the iron compounds which gives the characteristic brown or reddish-brown colour to the subsoil. The accumulation of colloids makes the subsoil stickier than the topsoil. Movement of air and water, penetration by roots and the action of lime results in a "nut" structure, particularly in loamy and clay loam soils. Subsoil can retain quite a bit of moisture and, if roots can

penetrate, the mineral nutrients are available in solution.

The C horizon consists of parent mineral material, gravel, sand, loam, silt or clay. On the watershed these materials are the products of glacial deposition. Their composition is determined largely by the underlying bedrock or rock in nearby areas. The type of material varies with the mode of deposition as described in the physiography section of this report.

3. Soil Classification

Within the soil group to which the Thames soils belong, the chief differences are due to physiographic origin. All soils formed on the same material belong to one "catena". Within one catena there are degrees of development of soils depending chiefly on the freedom of movement of water through them. These series of soils can be named individually or referred to as the excessively, well, imperfectly and poorly drained associates of the catena. In considering large areas like counties or watersheds, the catena and land form is the basis of land classification.

4. Soil Series and Types

A certain system of naming soils is followed by the Ontario Soil Survey, and is generally followed by those doing extension and research work. The basis of the system is the "soil series". Each series takes its name from the locality in which it was first identified. All the samples in a series have similar profiles.

The texture of the topsoil may vary within a series and adding the textural classification (e.g. clay, loam, silty loam, etc.) to the series name identifies a soil type. In fertility and crop response studies or farm planning the soil type is the basis of soil classification.

The soil types of the watershed may be listed

as follows:

Soils developed on heavy-textured glacial till:

Well drained -

Huron clay loam — Huron silt loam

Imperfectly drained -

Perth clay loam — Perth silt loam

Poorly drained -

Brookston clay loam — Brookston silt loam

Soils developed on medium-textured glacial till:

Well drained -

Guelph loam

Imperfectly drained -

London loam

Poorly drained -

Parkhill loam

Soils developed on coarse-textured glacial till:

Well drained -

Dumfries loam
Dumfries sandy loam

Poorly drained -

Lyons loam

Soils developed on uniformly stratified sand:

Well drained -

Fox sandy loam

Imperfectly drained -

Brady sandy loam

Poorly drained -

Granby sand

Soils developed on stratified sands and gravels:

Well drained -

Burford gravelly loam

Imperfectly drained -

Brisbane loam

Poorly drained -

Gilford loam

Soils developed on stratified sand over clay :

Well drained -

Bockton sandy loam

Imperfectly drained -

Berrien sandy loam

Poorly drained -

Wauseon sandy loam

5. <u>The Huron Catena</u>

The watershed is dominated by soils of the Huron and Guelph catenas. Both contain soils of high inherent fertility. Possibly the Guelph is easier to handle and is located on more favourable topography.

Soils of the Huron series have about 9 inches of dark brown loamy A1 horizon over 5 to 10 inches of light grayish A2. The B horizon, about a foot in depth, is a rich brown colour, slightly reddish, and has a well developed nut structure. It clods into a hard mass if cultivated when wet. The parent material is a gray stony clay. There may be a few stones throughout the profile. At any one site the thicknesses of the horizon are fairly uniform.

Both clay loam and silt loam types are found within the series. It would seem that the silt loam is easier to work, but in the use of these soils there was not observed any significant difference between the silt loams and clay loams.

The Perth series has a little deeper and darker looking A1 but a less pronounced A2 horizon. The B horizon has a mottled gray and brown colouring and a more compact, sticky structure. This mottling is characteristic of inadequately drained soils. It signifies that the ground water saturates the subsoil for part or all of each year. The typical brown colour of the subsoils of well drained soils is due to the iron oxides. When soils are wet and, therefore, poorly aerated, the brown iron oxides are reduced to gray-

coloured compounds. Generally speaking, the wetter the soil, the grayer and more pronounced the mottling in the subsoil.

Both silt loam and clay loam types are found. The silt loam is silty and almost entirely stone-free in the topsoil.

The slow drainage is due to the heavy nature of the material and poor external drainage or both. Unless steps are taken to improve the drainage, the Perth soils are usually unsuitable for winter grains and alfalfa although in favourable seasons may be quite suitable for spring grains and clovers.

Brookston clay is a typical poorly drained clay soil. There is a very dark, rich looking topsoil of 9 to 12 inches. It may be silty and under good management in good tilth, The subsoil consists of about 9 inches of very sticky, mottled clay. Both silt loam and clay types are found. The Brookston soils are, in many cases, the result of deposition of silt and clay by water in past ages. The silty soil is easier to work but the poor drainage in the subsoil and hazard of flood in spring restricts its use except where artificially drained. In the lower part of the watershed where the climate favours earlier working of the land, it may be used without artificial drainage for spring grain and corn. Up in Perth County the climate does not favour early planting and there is much less Brookston soil artificially drained.

6. <u>Guelph Catena</u>

Guelph loam is an easily worked, highly fertile soil which supports some very good farms. The profile is a good example of the type of soil which has developed in Southern Ontario. The topsoil varies in depth. There is about 6 to 8 inches of A1 and 6 to 18 inches of light grayish A2. Considerable variations in depth of A2 occur within a very small area.

Where soil is eroded or the A2 is shallow, the A1 and A2 get mixed in cultivation. It is convenient then to identify the topsoil as an "Ac" horizon.

The subsoil is a foot or more in depth and has a distinctive reddish-brown colour. It has a loose nut structure and is quite open.

The parent material is a gray stony loam. Pebbles, stones and boulders of rough, angular shape are present throughout the profile. In areas where the Guelph series predominates fieldstone houses and barn foundations are common, a feature lacking in areas of the Huron catena. The topography is gently rolling, often with regular smooth ridges. This physical landscape has favoured good farm layouts, but on the slopes, soil erosion is commonly seen.

The London series is the imperfectly drained associate of the Guelph. It is described as a brown loam (A1) over light grayish-brown loam (A2), grading into mottled reddish-brown and gray stony loam and clay loam. The A1 tends to be a little deeper and the B a little shallower than in the Guelph soils. The topsoil may be siltier.

This soil is naturally limited in its use by inadequate drainage. In years of favourable weather when early planting is possible there is considerable acreage of spring grains with apparently good yields. Large areas of the London loam type, however, do not appear to have the prosperous and established farms that are common on the Guelph soils.

The poorly drained associate of the Guelph and London series is the Parkhill. The profile is quite consistent, having a deep, dark-coloured loam topsoil and a grayish, mottled subsoil. The parent material and texture vary considerably. Sometimes the material is just the same as the Guelph and London. There may, however, be layers of silt or even clay. Because this soil is inherently fertile and has a deep topsoil but is limited in use by poor drainage, many

acres have been drained artificially for growing cash crops such as beans and sugar beets. When not artificially drained its use is limited to hay and pasture.

7. The Dumfries Catena

Dumfries loam is a coarse-textured, stony soil. It is very pervious to water and may be quite droughty. Because water moves through it so freely, it has a comparatively deep profile. The A1 is a grayish-brown loam and the A2 has 6 to 15 inches of yellowish loam. The B horizon consists of about 10 inches of reddish-brown clay loam. The parent material is a gray loam with both round and angular stones and boulders.

The sandy loam may have as much as 2 feet of A2 horizon and the topsoil is much sandier. Both these types lack fertility and quickly lose organic content unless very well managed.

In areas with Dumfries catena the topography can be quite hilly. It is found along a ridge of hills running south-west from Harrington West to the Cobble Hills in Oxford County. In hollows where the water table is high and there is poor external drainage the poorly drained series, Lyons, is found. In the Guelph catena similar areas of London and Parkhill are drained by single lines of tile but with the Lyons the extra effort of digging through stony soil to improve land which has little natural fertility is not worth while.

8. Fox Catena

Considerable areas of the Fox sandy loam and its associated soils are found near the city of London. The profile of the Fox sandy loam is three feet deep or more. The topsoil consists of an A1 horizon which is a light brown sandy loam. The A2 is a yellow sand of variable depth as much as two feet. The B horizon is a reddish-brown loam with a

fairly loose open structure. A parent material is a stratified stone-free sand, generally gray in colour and with a fair content of lime.

Because this soil is easy to work and warms up early in the spring, it is quite useful for cash crops, particularly tobacco and fruit. Because of its open structure and coarse texture, water moves through it very readily and it may become very dry in summer. Also, the original organic matter in the A1 horizon is soon worn out under cultivation. Where the usually flat relief associated with this soil is broken by steep stream valleys, the soil is subject to water erosion and, once the sand is exposed, to wind erosion.

Within the areas of Fox sand there are low spots with no effective surface drainage and a fluctuating high water table. In these areas are found the imperfectly drained associates called Brady sand, which has a deep A1, a shallower A2 which grades into the mottled gray and brown B horizon. Because of more favourable water relations, this soil may be considered to be a little better than the Fox, although it may be limited in its use by a late season due to water lying about in the fields.

The poorly drained series is called Granby. It has a topsoil which is normally quite deep but has a dark, nearly black colour. The subsoil is gray mottled sand. Because of its location this is often difficult to work due to water or wet conditions in the spring of the year. It is sometimes artificially drained, but this is not altogether to be recommended as in its natural state this soil can store quite a bit of water and when it is drained, it is subject to the same loss of fertility and organic material as its better drained associates, the Brady and Fox.

In some areas the sand deposits are quite shallow over clay. Usually the profile development is within the sand and the underlying clay is left unweathered. The impervious clay restricts the downward movement of water and

the profile in the sand resembles that of the Brady soil. The soil series is here called the Berrien and is usually found as a sandy loam. The well drained series is called Bookton and the poorly drained is called Wauseon. The latter soil may be artificially underdrained. All these soils are quite intensively used, particularly for market gardening and fruit growing.

9. Burford Catena

Along the broad flat bottoms of many of the valleys, the meltwater channels and spillways described in the physiography of the watershed, and also in broad flat plains near Thamesford are deposits of gravel and silt uniformly stratified.

The well drained soil in this catena is called the Burford and may be two types, a loam and a gravelly loam. Although there is some disadvantage in its gravelly nature or the occurrence of cobblestones, it is quite a useful soil. On the valley bottoms, however, it is sometimes subject to annual flooding and possibly leaching of mineral nutrients by the downward movement of water.

The Burford loam is described as a light brown gravelly loam with 6 to 12 inches of yellowish-brown sand or gravelly loam and a subsoil of 8 to 10 inches of reddish-brown clayey or silty loam. Parent material is stratified, glay, calcarious gravel.

The imperfectly drained associate is the Brisbane series and the poorly drained the Gilford series. These have progressively deeper and darker coloured A1 horizons and grayish mottled subsoils. The natural limitation to the use of these soils is the hazard of flood and moist conditions early in the season, although because of their permeable nature they may become quite droughty in the summer.

10. <u>Bottom Land and Muck</u>

Along some river valleys there are soils which are built up from year to year by deposits of silt and they show no profile development. These soils are designated as bottom land.

In some low areas with no surface drainage there is an accumulation of 18 inches or more of decomposed organic matter. These soils are called muck. If the water table is permanently high, the organic matter does not decompose completely and the result is a peat.

The bottom land muck and peat soils are usually covered by pasture or woodland, although much could be done to improve the management for these two uses.

A cut to show the profile of Guelph loam. Under the dark loam of the topsoil is a light gray level. The reddish brown subsoil is beside the shaft of the spade.

Dumfries loam. A coarse-textured permeable soil with a deep leached horizon (light gray beside the handle of the spade).

Tobacco is grown on the light, sandy soils of the Fox series.

CHAPTER 3

CAPABILITY CLASSIFICATION

1. Definition of the Capability Classification[1]

Land classification according to its use capability is done so in terms of its physical characteristics. The classes are named according to the uses or systems of management that will give the best return from the land without deteriorating the land.

The classification described in this chapter is one developed by the Soil Conservation Service of the U.S. Department of Agriculture and adapted for use in this Province by the Conservation Branch of the Department of Planning and Development and by the farm planning group at the Ontario Agricultural College.

There are four main classes of land subdivided into eight use capability classes. They are summarized here.

A. Suitable for cultivation with:

I - No special practices
II - Simple practices
III - Intensive practices

B. Suitable for occasional or limited cultivation with:

IV - Limited use and intensive practices

C. Not suitable for cultivation but suitable for permanent vegetation with:

V - No special restrictions or special practices
VI - Moderate restrictions in use
VII - Severe restrictions in use

D. Not suitable for cultivation, grazing or forestry:

VIII - Land may be of value for wildlife

2. The Land Use Capability Classes

I - Land which is fertile, nearly level, not eroded, well drained, which can be farmed under ordinary good farm management without deteriorating.

II - Land whose inherent characteristics include some lack of fertility or organic matter, sloping and eroded or

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1. Classifying Land for Conservation Farming. Farmers' Bulletin No. 1853. U.S. Department of Agriculture.

subject to erosion, or is naturally inadequately drained, which may be brought into a high state of production by overcoming fertility or humus deficiency, by checking erosion with simple practices, such as extended rotations or contour tillage, or which can be improved by simple artificial drainage.

III - Land of lower capability which can be sustained in production if protected from erosion by intensive erosion control practices, such as contour strips, diversion terraces; inadequately drained land which may be brought into full production by under-drainage; or land which can be used to only a limited extent because of shallowness, droughtiness, boulders, and so on.

IV - Land of low capability subject to erosion, which is difficult to cultivate, is inadequately drained or which is suitable only for a limited use, on which intensive soil-building practices and restrictions in use are necessary to maintain it in production.

V - Land which cannot ordinarily carry cultivated crops or a crop rotation but which can be maintained under sod or tree cover indefinitely without any special practices or any restrictions in its use. It usually includes bottom land and muck areas which cannot be drained.

VI - Land which cannot be tilled regularly because it is rough or is subject to erosion and cannot be exposed by regular cultivation, but which may be used for permanent improved pasture or for forestry.

VII - Land which must be maintained under sod or forest cover and, if sod, grazing should be controlled; and if under tree cover, planting on the contour, or when lumbered special methods followed to avoid wheel tracks and skid marks which might induce gullying.

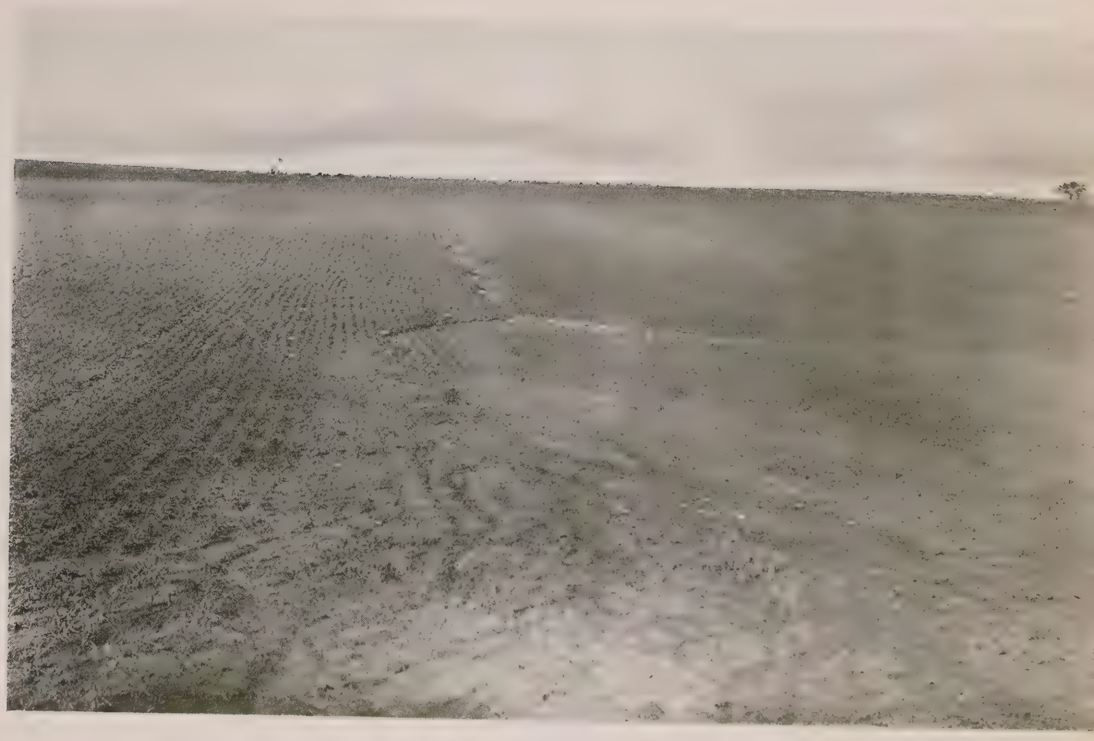
VIII - This class includes very wet places, bouldery areas or outcrops of bedrock and gravel beds which may carry enough vegetation to offer a shelter from wildlife.

Class I land on Perth silt loam that has been underdrained. This 1 per cent slope with no appreciable erosion has been seeded to a good mixture of grasses and legumes.

Class I land on well drained Huron silt loam: slope under 2 per cent with no appreciable erosion. The crop is Winter Wheat with fodder corn on the right.

Class II land, suitable for contour ploughing, is subject to erosion when ploughed up and down the slope in this manner.

Class III land. This field has been exposed to erosion until more than two-thirds of the topsoil has been washed to the flats. Shallow gullies have commenced in the furrows.



Class III land. On this 10 per cent slope sheet erosion is accompanied by shallow gullies. Only about 5 inches of the 18 inches of normal Huron topsoil found on adjacent fence lines remains, and accumulations at the foot of the hill have increased the depth of topsoil to 38 inches. The crop is Fall Wheat.

Class IV land. Rill erosion, forming gullies as a result of ploughing up and down the slope. Note accumulation of the topsoil in the hollow.

Class III and Class IV land on the slopes and Class V land on the bottom land of Trout Creek are typical.

Class III land on the slopes and Class V land on the flooded bottom. The slopes are between 10 and 15 per cent and have lost between one-third and two-thirds of their original topsoil.

Class V land at the headwaters of Trout Creek is covered by a woodlot.

Class VI land on slopes from 25 to 35 per cent. This land was still being cultivated up to the spring of 1945. Erosion has progressed to the extent that much of the subsoil had been lost, as well as the topsoil. In the spring of 1946 the owner planted this area with trees.

Class IV land. Unimproved Brookston clay loam is too poorly drained to be cropped in regular rotations and is best suited to hay and pasture.

Class IV land on a 12 per cent Huron silt loam slope where sheet erosion has reduced the topsoil to almost nil and small gullies have become frequent. The field is still being ploughed up and down the slope.

Class VI land. Rough, hummocky eroded Dumfries loam with slopes ranging from 15 to 40 per cent. Present pasture is poor, having a low carrying capacity, and much of it is recommended for reforestation.

Class VI land. Present woodland on rough Dumfries soil has been reduced to 20 per cent.

—By U.S. Soil Conservation Service

Class II and Class III land on smooth slopes can be protected from erosion and fast run-off of water by planting on the contour alternate strips of close-growing, erosion-resisting crops and cultivated row crops.

—By U.S. Soil Conservation Service

Class II sloping land is here protected by cultivating on long, easily worked strips on the contour.

3. The 1945 Conservation Survey of the North Branch Creek and Trout Creek of the Upper Thames Watershed

In this survey conducted by the Conservation Branch, more than 58,000 acres were examined in detail. The soil type was identified, 11 slope classes were identified and 5 grades of estimated erosion. At the same time the land use of each field was identified as cultivated, permanent pasture, woodland or idle. From comparisons of slope, erosion, natural drainage and soil type, the capability classification was derived. Herewith is the summary of the findings of that survey. First, it was found that soils of the Huron and Perth series are either flat or, if sloping, little more than 6 per cent slopes were found. Soils of the Guelph series were also mostly either flat or with slopes under 6 per cent, but some areas of irregular slopes up to 15 per cent occur. Soils of the Dumfries series are commonly found on rough, irregular slopes of 15 per cent. The less well drained series, Brookston, London and Parkhill and the Burford series were generally on level land. The incidence of erosion is summarized in the following table.

ACREAGE AND PERCENTAGE OF EACH EROSION GROUP

Erosion Group	Combined Acres	Area %
No apparent erosion	38,582	66.2
Slight erosion	11,926	20.5
Moderate erosion	7,216	12.4
Severe erosion	487	0.8
Gravel pits	31	0.05
Ponds	49	0.1
Entire project	58,291	100.00

Land use on the area was found to be 70 per cent crop land, 20 per cent pasture, 9 per cent woodland and the remaining area idle, covered by water or urban development. The Huron, the Perth, the Guelph and the London series had more

than 80 per cent in crop land, which is 10 per cent higher than the average for the area. The highest percentages of woodland were on the Brookston soils, where they did not have artificially drained land, on the Dumfries soils and on muck and bottom land.

A fairly high proportion of slight and moderate erosion were found on the Guelph and Dumfries soils, which is to be expected as those are the two soil types found on sloping ground. A direct relation was found by comparing estimated erosion to slope classes. On land which had slopes under 6 per cent, only slight erosion was found, but on slopes between 6 and 15 per cent most of it was moderately eroded and only about a quarter of it just slightly eroded. On slopes over 15 per cent about three-quarters is moderately eroded and the rest severely eroded. The degree of erosion is a little less on soils on rough, irregular slopes, presumably because these had been cultivated less than the smooth slopes. On crop land there was found to be no erosion on 64.7 per cent, slightly less than the "no apparent erosion" for the whole area. Slight and moderate erosion on crop land was found on a slightly larger proportion than on the whole area. On pasture land moderate erosion was found on 17 per cent of the area, which is considerably higher than the average, and on woodland only 4 per cent was moderately eroded. It would appear that enough of the woodland had remained from the original stand of trees to cut down the amount of erosion, but the high proportion of moderate erosion on pasture land would appear to indicate that much of this land had been relegated to pasture because of erosion that had taken place in the past.

Flat and uneroded land of the well drained series was grouped in Class I. Slopes under 7 per cent which, as was shown above, did not have a high degree of erosion, were put into Class II. Slopes over 7 per cent were put into Class III land, as were the Perth and London (imperfectly drained soils). Class IV land includes slopes up to 10 per cent if there was gullying, and up to 15 per cent if there

were no gullies found. Bottom land and muck were allocated to Class V. Class VI land included slopes over 15 per cent if gullying or severe erosion were found, and on slopes over 20 per cent. Gravel pits, sandy ridges which might be reforested were allocated to Class VII, and ponds were considered as Class VIII land. A multitude of classes of soil types and conditions, when thus grouped into eight classes, gave the following proportions: Class I - 36.3 per cent; Class II - 34.3 per cent; Class III - 6.7 per cent; Class IV - 11.4 per cent; Class V - 7.5 per cent; Class VI - 3.7 per cent; and insignificant proportions of Classes VII and VIII.

When the present use of the land of the capability class is determined, two interesting features are apparent. First, the land of higher capability includes higher proportions of crop land and the land of low capability includes higher proportions of pasture and woodland, so that in general there is some adjustment of use to capability. The second feature is important in considering the future. There are still significant areas of land of low capability which are being used intensively for crop land. What is of further significance is that although much of the land of the low capability class, on account of drainage, is artificially drained, none of the land subject to erosion was being protected by any special tillage methods, and little of it being protected by any cropping systems designed to check erosion. The use of animal manure, limited use of green manure crops and a haphazard reliance on crop rotations were the only means of protection against erosion that were found.

4. Results of the 1945 Survey

Although some of the soil types found on the whole of the Upper Thames Watershed do not occur in the sample area done in 1945, a good deal was learned about soils of the Guelph, Huron, Dumfries and Burford catenas. The increasing incidence of erosion with increasing slope, the intensive use

of the less sloping and less eroded soils, the degree to which the use of the inadequately drained soils depended on artificial drainage, gives a basis for assigning different types of land to the use capability class, and in the survey carried out in 1950 land was allocated to a capability class directly in the field without reference to the more specific slope and erosion class. In this way it was possible to do a reconnaissance survey of the entire watershed, having previously examined a smaller part of it in detail.

Similar work was done by the Conservation Branch on the watershed of the Ausable River in the summer of 1947, and soil types found on the Thames Watershed, particularly the Berrien and Fox series, were examined in detail and capability classes assigned to them. Further, the problem of neglected pasture and compaction of clayey soils of the Huron catenas was studied. The importance of pasture improvement in bringing these soils into a more productive state and making them less susceptible to erosion and accelerated run-off was studied so that again, on the reconnaissance survey, land could be allocated to a capability class from direct observation on the field.

CHAPTER 4

RECOMMENDED LAND USE ACCORDING TO USE CAPABILITY

1. Conditions Which Lower Use Capability

Certain conditions are generally recognized as lowering the use capability of soil - lack of fertility, inadequate drainage, droughtiness, stoniness and rough topography. Erosion, susceptibility to erosion, compaction, droughtiness resulting from erosion and lack of organic matter are not so generally recognized.

The capability classification described in the previous chapter is a "rating" of capability. The soils with lower ratings (II, III, IV and so on) have progressively poorer inherent capability or require more intensive practices (drainage, tillage methods for erosion control, extended rotations) to sustain them in production without deteriorating.

In this chapter there will be outlined a classification of "recommended" land use, according to use capability. In each class the recommended use is related to the condition which lowers its capability rating. This system avoids the numbering of classes and names them explicitly in terms of the recommended use.

2. Erosion, Run-off and Slope

The results of the detailed survey in 1945 showed how the degree of erosion increased with slope and how erosion affected land use. There is evidence of decreasing yields on eroded land which has lost its topsoil. Tests made on gently sloping plots of Huron soil near New Hamburg show how much soil and water is lost by erosion. These tests also show how much less is lost from land covered by sod or protected by contour tillage.

More serious, probably, than the loss of topsoil by erosion is the loss of water and the lower ability of eroded land to absorb and retain moisture. When land is

The spring thaw washed out this small gully on a 3 per cent slope near Stratford.

A heavy summer rain did this damage in less than one hour on a farm near Stratford.

Long smooth slopes like the one in the background on No. 7 Highway near Rannoch are very subject to erosion but can be controlled by contour methods of cultivation.

kept under cultivation, particularly where furrows and drill rows run up and down hill, topsoil is eroded. The soil that remains cannot absorb rainfall so readily, thus run-off is increased and both erosion and accelerated run-off are aggravated.

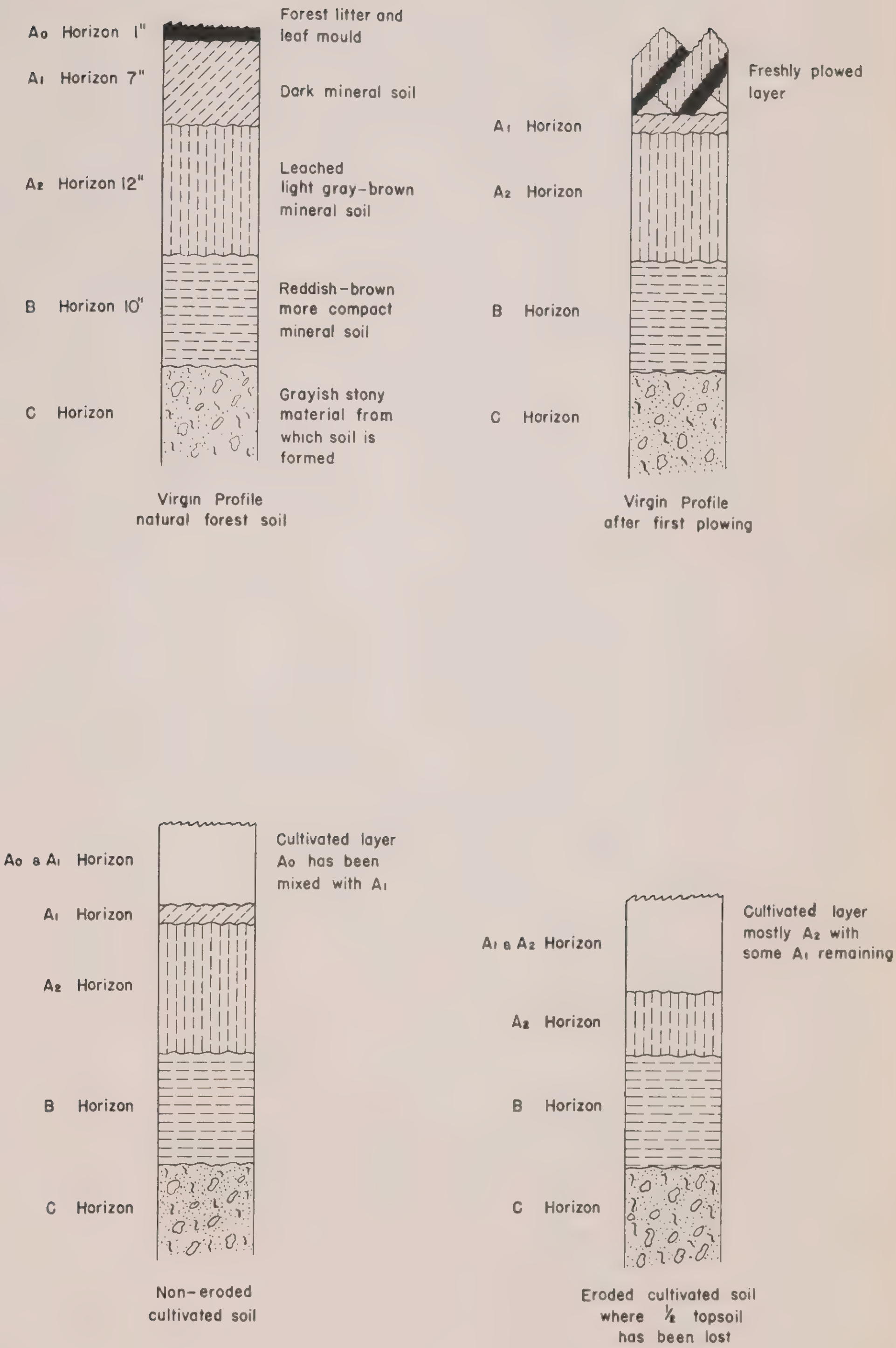
If water is held by contour cultivation and soil organic matter built up, the soil is improved with respect to moisture absorption. For example, there is much less erosion and water loss on a cornfield when corn follows a soil-building crop than from corn following corn or other tilled crops.

Even though examination of a soil on a slope does not reveal any serious erosion in the past, there is always the possibility of erosion if it is found on similar slopes. Any method of checking erosion on land susceptible to it should increase the moisture-absorbing and holding capability of the soil and cut down on the hazard of drought.

3. Identifying and Estimating Erosion

The most obvious evidence of erosion is gullying or, in the case of sand, blowouts. Deposition of soil at the bottom of a slope due to "soil wash" is also commonly seen and recognized. Rills, or small gullies, form in implement tracks, dead furrows or between rows of corn or other intertilled crops. These, however, are soon obscured by cultivation or crops.

Less obvious evidence is the piling up of soil on the uphill side of a fence or the cutting away on the downhill side. In addition to all these surface clues to erosion there is an indirect clue. That is in crop response. When soil is eroded it is usually more droughty. On bald eroded slopes the growth may be quicker on dry soils in the wet early spring, but through most of the year the growth is poorer. Patchy crop response on slopes is a good way of detecting erosion.



The above diagrams illustrate the various horizons found in the profile of Guelph loam, typical of the well drained soils of the region. The extent to which erosion has progressed may be ascertained by comparing the thickness of the present upper horizon with that of the same horizon in an undisturbed situation on similar slope.

There is one way of detecting and estimating erosion which is independent of seasonal changes or superficial evidence. This is examination of the soil profile.

Once a soil type has been identified at a location, an example of a good profile may be found in a woodlot or along a fence row on level or nearly level land.

In one example a full profile might show, say, 30 inches to the bottom of the subsoil (B horizon). This can be identified by using a dilute solution of Hydrochloric (or Muriatic) acid. The acid effervesces, or fizzes, on free carbonates which are not found within the A or B horizons. If, on the suspected erosion site, free carbonates are found at 20 inches then something like 10 inches of soil has been lost.

Of course the depth of profile may vary and the acid test may not be very definite, but if, by feel and sight, the horizons can be identified a good estimation of the degree of erosion can be made.

4. Inadequate Drainage

Removal of surplus water from the soil by natural means may be due to one or more of three factors. First, the ground-water table may be near the surface. This condition is found in low-lying areas and sometimes in upland regions. Second, the surface relief may be such as to check overland run-off of water to a stream course. The third factor is an impermeable soil, usually a clay, especially those which have been compacted when they were deposited.

The ill effects of inadequate drainage on agriculture are well known. Water lying on fields in spring delays cultivation and planting. Clay soils cannot be tilled in a wet condition. Winter killing and heaving are more likely in wet soils. Soils saturated with water are kept cool until later in the season so that germination and growth are delayed. Moisture in soils excludes air which is

necessary to plants and to microscopic life within the soil.

Crops on poorly drained soils which dry out in summer are more subject to drought. This is because roots cannot penetrate so deeply during the actively growing season and if the weather is dry later, in July and August, the plants' roots are not down deep enough.

Poorly drained soils provide less storage capacity for moisture, partly because they may be saturated at the time surplus rain falls and partly because they do not have the open structure of well drained soils that lets water penetrate.

Where poor drainage is due merely to surface irregularities it can be remedied by ditches. High water tables and standing water in low spots can be remedied by single lines of tile.

Broad areas of poorly drained clay are artificially underdrained by using tile in grid or herring-bone patterns. The tile mains lead to outlet in streams and where streams are not well defined ditches are dug.

Inadequacy of drainage is often obvious from the evidence of standing water, wet spots or poor crop response Regardless of season the state of drainage can be identified by examination of the soil profile. Well drained soils have characteristically brown or reddish-brown subsoils. Imperfectly drained soils have mottled brown and gray subsoils and poorly drained, gray subsoils with some brown mottling. This condition can be examined no matter how dry it is at the time.

5. Compaction

Soil is compacted when its constituent particles come together and reduce the pore space, which holds air or water, between them. This may be a natural condition of the soil due to its mode of deposition under pressure of the ice or due to the physical properties of the clay, which may be quite massive, or it may be due to poor drainage. Compaction

may be the result of its use. This may be due to the actual weight of implements or to the soil particles being broken into finer particles by cultivation and then puddled by water to make a massive clay. It may result from trampling by cattle. Further, it can be due to loss of organic matter which ordinarily helps to maintain soil structure when the soil more or less "collapses" when the organic matter is depleted.

This condition is found particularly on the Huron and Perth soils where these have been neglected and used for pasture without any improvement practices. In this condition the soils deteriorate, plants do not root as well, they are less absorptive to moisture, run-off is accelerated and, if it is sloping, so is erosion. Where these soils require breaking up mechanically to a greater depth than is usual in ploughing, it may be necessary to use deep ploughing or sub-surface tillage. Mechanical operations, however, will not entirely correct this condition as they have the tendency further to pulverize the soil and make it subject to compaction, particularly during heavy rains. The breaking up of these soils by deep-rooted legumes should improve the subsoils and the re-establishment of a good organic content in the topsoil should bring them into good tilth. This may be done by top dressings of manure on pasture or by growing green manure crops or bringing them into a crop rotation with an emphasis on soil-building crops, the grasses and legumes. The generally poor state of pastures and the obviously poor tilth of top soils is enough evidence to indicate this condition on soil types which are ordinarily quite productive.

6. <u>Cover Crops</u>

Ploughing under cover crops and maintaining vegetation on sloping fields over winter have two beneficial results. The first is to increase organic content of the soil by adding these crops to it. The second is to provide a mechanical check to the overland run-off of water, particularly

in the late fall with its heavy rains and the early spring with the thaw. There is some evidence too that the maintenance of cover crops during the frost period has a beneficial effect on soil structure generally.

7. Pasture

Maintenance of improved pasture on land held under pasture for six or seven years or cultivation for a crop and then re-seeding to pasture are the greatest single erosion control measures with respect to the area on which they may be applied. Compared to the land subject to erosion which might be protected by contour tillage, the area which can be protected by wise use of cover crop and by the use of improved pasture is very great. Pasture, when seeded, fertilized and managed, gives far greater returns in beef or milk than pasture which is left to run wild indefinitely. Pasture improvement is, therefore, a good step to take from the farming point of view alone. It is also good to control erosion and accelerated run-off. Again, as with the cover crops, it tends to build up organic content of the soil and provides a mechanical check to overland run-off of water.

8. Contour Tillage

On smooth slopes whose only disadvantage is susceptibility to erosion and accelerated run-off, there are methods of tillage which check erosion mechanically. These methods include ploughing, cultivating and seeding on the contour, that is, along the level rather than up and down hill, and the establishment of strip-cropping on the contour. An example of this might be 20 acres of land all on one smooth slope. Supposing that a four-year rotation is normally carried out, then the field should be struck out into four strips of 5 acres each. Two might be seeded to grasses and legumes for hay, and the alternate strips seeded to grain and corn as they appear in the rotation. At the end of two years the sod of the meadow

A grassed waterway in a field of grain near Fullarton is good farming practice and good erosion control.

On smooth slopes alternate strips cultivated "on the level" save soil and water. This is on a farm near Byron.

Improved stands of grass and legumes constitute the most effective tool in building soil, saving moisture and resisting erosion. They produce good milk and beef, too. This splendid example is on a farm south-east of Ingersoll.

strips is ploughed under and made available to the crops while the strips which were cultivated for two years will be under grass. At the end of the four-year rotation each piece of land would have had its two years meadow and two years field crops and in any one year the sod of the meadow checks any run-off and soil washed from the cultivated strip.

9. Diversion and Grassed Waterways

Along with contour strips or as a measure by themselves diversion terraces or ditches can be struck out across the slopes. They are not absolutely on the level but are led slightly downhill towards a safe outlet. They may be constructed by ploughing or by using terracing equipment. Any water, with its burden of soil, that is washed down from the upper slope is caught in the diversion. The soil suspended in the water is deposited out as the flow is slowed down and the water is led slowly across the hill.

To dispose of the water from the diversion or merely to carry the water of the natural watercourses harmlessly across the field it is wise to have a grassed waterway. This may be achieved once the field is in sod by merely tripping the implements as they cross the watercourse and the stand of sod is retained along the path of the water. In some instances it is necessary to construct the watercourse by ploughing and grading and then establishing a good seed mixture which will establish sod within one season. Where there is a steep drop it might be necessary to lay sod cut from some other place. A bulletin on the construction of "Grassed Waterways"[1] is available from the Ontario Department of Agriculture.

10. Recommended Land Use According to Its Capabilities

The following are the seven classes of land indicated on the map which accompanies this report and a description of them.

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1. Grassed Waterways:Ontario Agricultural College Circular 81. 1950.

L - Cultivated Land

Included in this class are soils of the Huron, Guelph, Fox and Burford series which are fairly level and not subject to erosion.

There are no restrictions on the use of these soils nor any special practices over and above what is recognized as good farming to keep them in a cultivable and highly protective state indefinitely.

LR - Restricted Cultivation

Soils of the Dumfries series, even though level, and soils of the Guelph, Huron, Burford and Fox series, which have mild (that is less than 15 per cent) but irregular slopes which are subject to erosion and accelerated run-off but which do not lend themselves to mechanical methods of erosion control.

Erosion can be controlled from these soils by extending the rotation to include more soil-building crops and less grain and a minimum of intertilled crops, such as corn, beets, mangels and so on. Erosion in late fall and early spring can be checked by maintaining them under winter grain which may be in rotation or as a catch crop.

Diversion channels can sometimes be constructed to intercept the flow down these hills and in some cases single lines of tile are necessary to drain low-lying spots.

Soils of the Perth and London series are also included in this class if they are sloping, as they are also subject to erosion even though some provision has to be made to improve their drainage. If they are drained by tile, or left with dead furrows up and down hill during winter, it might be well to break the slope with strips of sod or diversion channels.

CF - Contour Cultivation

This class includes smooth slopes up to about 15 per cent on soils of the Huron, Perth, Guelph, Dumfries, Burford and Fox series that have been eroded or, because of their slope, are subject to erosion.

On slopes up to 4 or 5 per cent, regular cultivation and crop rotation may be maintained if the fields are struck out so that cultivation is along the contour, that is, "on the level" rather than up and down the slope. On steep slopes contour strip-cropping should be practised. If the slope is not long enough to allow for alternate strips of grassland and cultivated land a buffer strip of sod may be left across the slope or a diversion terrace established.

LD - Drainable Land

All the soils of the Perth and London series that are not subject to erosion, and much of the Brookston and Parkhill soils where suitable outlet can be found, can be brought into a high state of cultivation and made to conserve moisture if they are artificially drained.

Some of the Perth and London soils can be adequately drained with field ditches or merely striking out dead furrows to act as small ditches. Sometimes the small areas of these soils are found in depressions and can be adequately drained by single lines of tile. In some instances it may be worthwhile, particularly in the Parkhill and Brookston soils, to install thorough systems of tile underdrainage. Much of these soils has already been treated in this manner.

Although ditches are required to provide outlet for tile on these soils, much of the area is now adequately served in this respect and if further ditching is necessary some caution must be used in the safe construction of ditches and against digging where ditches are not necessary. There is a strong feeling that excessive ditching accelerates flow in the river system and contributes to flood, and evidence of this is easily seen, particularly in the location of the ditch itself. Moreover, once an outlet is established it should not be necessary to strike a ditch straight through to a natural outlet. Where this is done there is a tendency for a great deal of ice to pile up and when the ice jam breaks there is local flooding

and a minor flood crest passes on down the river.

There is some question of the advisability of the intensive under-drainage on the soils of the Huron Catena in the north part of the watershed. Apart from any problem of drainage aggravating flood conditions, there is a question as to the actual economic value of drainage in that area. It is located towards the north limit of cash cropping of wheat and the growing of corn for husking. That is, even on well drained soils, there is not the intensive use that there is further south and down stream and the cost of under-drainage must be weighed against benefits. If wet soils are too late for corn for silage they can still be used successfully for grass and legume mixtures which are suitable for ensiling and much can be said of the advantage of this type of farming. Indeed, for either erosion control or optimum use of inadequately drained soils, grassland farming and the use of grass silage have many arguments to support them. Some poorly drained Perth, Huron and Brookston soils have not adequate outlets for artificial drainage and use is naturally restricted by poor drainage. Best use can be made of these soils by seeding them with species of grass and legumes that are tolerant of wet conditions. Timothy and red clover may last for some time, although orchard grass is more commonly found. Reed canary grass is recommended for these soils but is not commonly found. Unless well managed with rotational pasture or regular clipping it tends to become coarse and unpalatable. On similar conditions in New York State, Bird's Foot Trefoil has been found useful as it is tolerant of wet conditions and produces fodder which, though not as satisfactory as alfalfa, is much better than what is obtained by letting hay and pasture go wild on these soils.

ND - Not Drainable

Lyons loam, poorly drained associate of the Dumfries soil, is too stony and bouldery to lend itself to artificial drainage. The poorly drained associates of Burford found in the valley bottoms would not appear to be suitable for

artificial drainage as they are so pervious as to become droughty and to lose fertility very easily. More study might be made of this problem but no examples were found on the watershed of intensive use of these soils.

The poorly drained sands are not recommended for drainage unless they have a very large organic soil overlying them and can be managed without danger of drought for special crops, particularly market gardening.

P - Improved Pasture

A good deal of land suitable only for pasture is already under grass, but with respect to area very little of it can be said to be well managed. Carrying capacity is not nearly as high as it might be. Weeds are common, especially wild carrot (or Queen Anne's Lace) and there is evidence of serious compaction. In upland regions pastures dry out in summer, probably because of the poor absorptive and retentive capacity of the soil for moisture.

Not only to improve production, but to improve the absorptive and holding capacity of these soils for the benefit of the whole watershed, these pastures could well be improved.

As was seen on the detailed study done in 1945, lands of steep slopes over 15 per cent are commonly seriously eroded and yet much of them are still under cultivation. It is not practicable to apply methods of contour cultivation on these soils, but they can be protected with improved stands of pasture which can yield nearly as well as pasture on better lands.

In the matter of pasture improvement reference may be made to publications on this subject by both the Ontario and Dominion Departments of Agriculture. Splendid examples of pasture improvement can be found on the farms co-operating with the Ontario Crop Improvement Association and the Department of Agriculture. The County of Middlesex has carried out some valuable studies on pasture renewal, renovation and management. The results of these studies and demonstrations can be applied to a great deal of the land which is indicated as recommended

for improved pasture on the map which accompanies this report.

F - Woodlots and Reforestation

Much of the existing woodland on the watershed is to be found only in the very poorly drained areas. Small woodlots are found commonly on the backs of farms irrespective of soil types. Most of these could be improved in their management and this is discussed in the Forestry section of the report.

Steeply sloping land and land which has been gullied or wind-eroded should be put under forest cover by reforestation. Large areas for reforestation are indicated on the Forestry map accompanying this report, and areas which might be reforested by individuals are indicated on the Recommended Land Use map.

CHAPTER 5

PRESENT LAND USE

1. Present Land Use

An inventory of present land use is made for two reasons. First, to estimate the capability of the land, taking the present use as an indication of the experience of those who have been using the land for generations. Second is to estimate the degree to which use is adjusted to capability and the extent to which changes in use or management are required to bring all the land into its wisest use.

Present use of land over the whole area was mapped in six classes; in the order of the intensity of use and degree to which they expose land to soil erosion and water run-off they are as follows: idle (wasteland), forest, pasture, cultivated (in regular crop rotations), row crops and urban use.

2. Forest

Land which is covered by trees to at least 40 per cent of the area is considered woodland. It may or may not contain merchantable timber and may be only scrub growth. Much of it is pastured, but as it could become useful forest if ungrazed it is still classed as forest.

Some areas are not cultivated, grazed or supporting any tree growth and they are classed as idle.

3. Pasture

If land appears to have been under sod for longer than might be expected in any rotation it is considered to be pasture. This includes wasteland pasture, that is, land which has been cleared but has never been regularly cultivated. Some pastures have been established in the past by allowing formerly cultivated land to go to grass. Some were seeded to grasses years ago and have never been turned under since.

Pasture, hay and grain with a herd of beef animals, on Huron & Perth soils near Kinkora.

The milk herd is the backbone of agriculture. This mixed herd is grazing on improved pasture on a clay soilin Blanshard Township.

Under good management high yields of oats and other grains are obtained, like this field on London loam near Zorra Station.

4. Cultivated

Classed as cultivated is all that land which appears to be within a crop rotation of some sort and includes not only grain, clover and alfalfa but stands of hay or even of pasture when it is a recent seeding and appears likely to be turned under in due course in the rotation.

5. Row Crops

Included in this class are corn, roots, tobacco, beans and truck and fruit crops. These usually represent a more intensive use of land and they not only make heavier demands on the soil without returning anything to it but in their cultivation expose land to soil erosion if they are on slopes.

6. Measuring Land Use

The actual use of any particular piece of land is of little consequence except to the man who operates it. This survey is an inventory of soil and land use of the whole area and it is the relative proportions that are significant, not the use on any one field at any given time.

To determine the proportions of use only about one-third of the area was actually measured. This was done in this way. The mapping on the aerial photographs was traced on to large sheets of vellum, using an instrument known as the Abrams Sketchmaster. On the vellum a grid is drawn to indicate the roads at the scale of the photographs. An image of the mapping on the photo is projected on to the vellum and, by adjustment of the instrument, distortions and variations in scale are corrected.

The measuring of areas, or "planimetering", was done with a dotted template. This is a transparent sheet of "acetate" on which are printed dots which represent one acre of land on the scale of one inch to a thousand feet.

The area to be planimetered was chosen from regions scattered around the watershed which were considered representative of all the types of land and classes of land use that are found.

7. Summary of Land Use

Some 313,000 acres were analyzed. The following table shows the acreage and proportion of each use.

Use	Acres	Per Cent
Row Crops	21,597	6.9
Cultivated	195,983	62.6
Pasture	69,130	22.1
Forest	21,684	6.9
Idle & Urban	4,641	1.5
Total	313,031	100.0

Row crops and all other cultivated land together account for 69.5 or nearly 70 per cent of all the land. The figure of 6.9 or nearly 7 per cent of the land under forest cover is very close to that determined for the whole watershed in the survey of woodlots.

To summarize, present use is in roughly the following proportions:

Cultivated	70 per cent
Pastured	22 per cent
Wooded	7 per cent

Any program of soil conservation must take into account the demonstrated demand for regular cultivation on 70

per cent of the land of the watershed. If, for conservation purposes, more land is required to be under sod or trees, then the productivity of the cultivated land must be increased. The proportion of cultivable land will be shown in Chapter 7.

FARM TYPES

On the basis of types of herds with the incidence of cash cropping.

This mapping served two purposes. It helped to determine the farming regions on the watershed and it indicated somewhat the extent to which intensive land use is significant in soil conservation.

Apart from the returns to the farmer and the help that cash cropping can be to him in his own economy, there are two features of cash cropping that are important to consider in soil conservation, one good and one bad.

If soils and climate are suitable for cash cropping and it can be done without robbing the soil, the economic advantage can be a great benefit to a region. Some of the cash returns can be used in improving other phases of the farm operations such as purchase of better breeding stock, which in turn gives a higher return in the sale of young stock, which is an important part of a farm income. Profits may be used in the purchase of new equipment to handle the soil better, in purchasing fertilizer or in improving run-down pastures. Areas of favourable soils on which cash cropping and animal husbandry are combined often show a better economic stability and less problems of soil conservation than areas that have not this advantage.

Cash cropping becomes dangerous when it is so concentrated in an area that soil-building crops are not included in the crop rotations and there are few or no animals to assist in returning fertility to the soil. It is also dangerous when it is introduced to a soil which is susceptible to erosion by reason of slope. Intertilling of many cash crops seriously aggravates the erosion menace and persistent cash cropping may dangerously reduce the organic content of the soil. There is a tendency, however, for these crops to become established on lands unsuitable to them in regions where they are grown and especially during times of great demand and high prices. Granted that the movement may recede when times are less favourable, but once established they tend

to persist until the soil is rendered quite unsuitable for them and after irreparable harm has been done to the soil by erosion.

3. Farm Regions

From the classification of farms on the basis of types of herds and the incidence of cash cropping, six regions may be separated out. Each of these has a fairly distinct set of physical features associated with it. In describing each the dominant types of land use, the physical characteristics and the conservation problems of each one will be noted.

4. The Perth County Region

A line joining Mitchell and Stratford separates to the north of it an area quite clearly dominated by beef production. This is the south-easterly lobe of a much larger area in Perth and Huron Counties that has this type of farming. The soils are largely of the Huron and Perth series. The land is flat to undulating with very little bold relief. Some soil erosion is found on the Huron soils on slopes, yet the land does not lend itself, over any large areas, to the practice of contour cultivation. Both the Huron and Perth soils show evidence of compaction with pastures that are more sparse and weed-ridden than should be on these inherently fertile soils. The Perth and Brookston soils are limited in their use by inadequate drainage, and despite the extensive ditching in the area the soils are still inadequately drained. Where dairy herds were found in the area they seemed to be associated with the ridges of better-drained soils, possibly because they could carry more alfalfa and grain. Cash cropping is for wheat and flax. Ponds are necessary for pasture and are commonly of the dug-out type.

The problems of erosion and soil compaction call for emphasis on pasture improvement and soil-building crops with extended rotations on the hummocky slopes to expose land to erosion for a minimum time. On the Perth and Brookston soils, if artificial drainage is neither practicable or

economic, then use of grass and legume mixtures tolerant of these conditions is indicated.

5. <u>The London Township Region</u>

London Township is in the heart of a region which occupies the western edge of the watershed from Granton to London. As to land use, this is a very mixed region. Along the western divide there is a distinct region of beef production. This is the eastern edge of the west Middlesex and Lambton beef area. Most of the region is very mixed in type of herds. There is considerable cash cropping in the area, notably for sugar beets, wheat and barley.

The prevailing soil type is that of London loam which is imperfectly drained. Unless artificially drained this soil is of limited use and might be expected to carry beef animals as on other inadequately drained soils. Proximity to London gives an economic advantage to milk production. The Parkhill loam and the muck soils on the valley bottoms are artificially drained and used for cash crops, particularly sugar beets. The region looks as if it had not yet achieved stability and is likely to change in character. If it is to be anything but a beef region there will have to be more artificial drainage. It is drained by the Medway Creek and the North Branch of the Thames, and these are the streams which seem to contribute most to flood hazards in London and further drainage may be opposed by those who are concerned with flood control. In this connection it is remarkable that it is on the watershed with the flatter and less well drained land that the greatest flood peaks are built up.

The valleys in this region have broad smooth slopes and where they are not too steep they might be maintained under cultivation by using contour methods. Woodland is sparse and restricted to very wet and low spots. If artificial drainage is uot undertaken then better use can be made of the soils by adapting grass mixtures to the less well drained soils.

6, The Thamesford-London Plain

Between Thamesford and London there is considerable cash cropping along with the predominant dairy farming. This is because of the easily worked, warm, early soils of the Fox, Berrien and Burford series. As long as intertilled crops are kept off the erosible slopes and there is a prevalence of animal husbandry there should be no special soil problem. Truck crops and fruits are likely in the future to call for more irrigation and for water for spraying so that along with the construction of ponds there will be a greater concern for sustained flow in the streams. On rougher locations these light-textured soils might well be reforested to help conserve water.

7. The Oxford County Region

That part of Oxford County which is within the watershed is the heart of a region which contains small parts of Middlesex and Perth Counties. It is recognizable from the map of farm types as predominantly given over to dairy herds. It is the very heart of the old-established cheese region of Western Ontario.

The commonest soil type is the Guelph loam. There are inclusions of the less well drained associates, London and Parkhill, in the low-lying areas and soils of the Burford catena on the valley bottoms and terraces.

The south-eastern corner of the region has some well defined "drumlins" - long, oval hills or "whalebacks". The rest of the area is fluted and ridged so that the landscape seems to roll and swell as one traverses it. This is a very favourable type of topography for general farming. The easily worked and generally fertile Guelph soils usually support good farms wherever found.

Because of the sloping nature of the land considerable soil erosion is found. As the slopes are quite long and smooth they lend themselves to those types of erosion control that depend on contour tillage. One good example of

contour tillage which has been established for some time in the area happens to be on the smooth slopes at the edge of the river valley at Beachville, but the same sort of thing might be practised on a good many of the slopes in the region.

Demand for winter feed for milk animals calls for a large proportion of this land to be cultivated for grain and legumes. To check soil erosion losses and consequent risk of drought the whole range of conservation farming practices has considerable scope in this region.

8. The Lakeside Region

From Tavistock through Lakeside to Cobble Hill the map of farm types shows a rather mixed region with more beef production than the country around it. This is associated with soils of the Dumfries series and rougher phases of the Guelph soils. There is a greater proportion of pasture on these lower capability soils and future use of the area will depend on good pasture management.

9. The Komoka Region

The high incidence of cash cropping down stream from London indicates the invasion of the watershed by tobacco. Fruit and truck gardening is also found. These uses are carried out on soils of the Fox and Berrien series.

Characteristic of the region is the sharp dissection of the land by many streams and ravines leading to the Thames. There is also considerable woodland on the rougher areas. There is serious danger of erosion on the steep slopes, also of water loss and soil organic content depletion.

10. Significance of the Regions

A soil conservation program is necessarily a local responsibility because it will be actually carried out by the people on the land. Any outside assistance, particularly from the Conservation Authority, should be planned with reference to the characteristics of the land in any one

locality. It is suggested that any steps taken to promote soil conservation be done on a regional basis, using the regions here outlined in terms of types of farming and physical conditions.

CHAPTER 7

THE ADJUSTMENT OF LAND USE TO USE CAPABILITY

1. The Use Capability Classes

In the chapter on Land Use it was shown that 70 per cent of the land was under cultivation in regular crop rotations. This indicates the demand for cultivable land under the prevailing economic conditions and types of farming, which, as has been shown, is predominantly for milk production. Attention was also drawn, in the chapter summarizing the 1945 survey, to the fact that there was no organized effort to control erosion beyond the ordinary use of manure and crop rotations. Since 1945 a few demonstrations of conservation measures have been set up and considerable advance has been made in pasture development. The question remains, is there enough land of high capability which, under the proper management, will carry cropland on 70 per cent of the area? The following table gives the answer.

L	Cultivable land	2.8%
LR	Restricted cultivation	26.9%
CF	Contour cultivation	17.9%
LD	Drainable land	32.7%
Total		80.3%

The small percentage of land suitable for cultivation without special practices, (L) presents no problem. Supposing, on LR land, that rotations were extended from 4 to 5 years, the proportion of grain is only lowered 20 per cent. Land suitable for contour cultivation, (CF), can be retained in a 4-year rotation so that under proper management of erosion control there is no lessening of cultivated land. These three would then add up to 44.8 per cent which subtracted from 70 per cent leaves 25.2 per cent. This is only five-sixths of the land designated as drainable. Therefore, discounting that yields on sloping land subject to erosion should increase, and a

TABLE A

PER CENT OF CAPABILITY CLASSES IN EACH PRESENT USE

Use Capability	Present Use R	L	P	F	X	Totals
L	3.6	3.3	1.4	1.3	0.2	2.5
LR	31.3	30.6	20.4	11.7	16.2	26.9
CF	29.0	21.2	9.7	7.5	3.8	17.9
LD	30.7	35.2	30.5	22.1	12.6	32.7
ND	0.1	0.2	0.6	0.5	0.6	0.3
P	2.4	2.8	7.5	3.3	3.1	3.9
F	2.9	6.6	29.9	53.5	63.5	15.5
Totals	100.0	100.0	100.0	100.0	100.0	100.0

TABLE B

PER CENT OF PRESENT USE IN EACH CAPABILITY CLASS

Use Capability	Present Use R	L	P	F	X	Totals
L	6.5	77.6	12.1	3.7	0.1	100
LR	8.0	71.3	16.8	3.0	0.9	100
CF	11.1	73.8	11.9	2.9	0.3	100
LD	6.3	67.3	21.2	4.6	0.6	100
ND	2.4	33.2	48.5	12.7	3.2	100
P	4.4	45.9	42.6	5.9	1.2	100
F	1.3	26.2	42.6	23.8	6.1	100
Totals	6.9	62.6	22.1	6.9	1.5	100

sixth of the drainable land which might never be drained, there is still enough land suitable for cultivation to meet the demonstrated demands. This is a very encouraging answer. A further comparison of the present land use with the use capability should reveal the extent to which use is adjusted to capability and the extent to which use should be changed to conform to the natural characteristics of the soil. The two accompanying tables summarize these situations.

2. Extent to Which Use Is Adjusted

Referring to Table B, the present use of the land in each capability class can be compared to the average use for the area. The most extensive use capability class is that recommended for drainage. It represents (Table A) 32.7 per cent of the area. The proportion of it in each present use is very close to the average for the area. (Compare the percentages in line LD with those in the bottom line.) The next largest area is that recommended for cultivation with some restrictions in use, LR, 26.9 per cent. The proportions of it in row crops and under cultivation is considerably higher than the average for the area, 8.0 and 71.3 as compared to 6.9 and 62.6 per cent respectively.

Of the land recommended for pasture only 45.5 per cent is cultivated, compared to 62.6 for the whole area, whereas 42.6 is now pastured, which is far higher than the 22.1 per cent of the area which is now pastured.

Reading the table of percentages in this way it is easy to see that, in general, the lands of higher capability are used more intensively than the lands of lower capability. Again the answer is reassuring, but it is obvious that there is not a really close fit of use to capability.

3. <u>Degree of Maladjustment</u>

Twelve per cent of the land suitable for continued cultivation is under permanent sod and 3.7 per cent is wooded. Granted that these proportions are small compared to the use over the whole area analyzed, it still means that some land of high capability is relegated to a lower use. That this is so is partly due to the rectangular layout of farms <u>and fields</u>. Rectangular woodlots and fenced pastures sometimes include areas of land of better capability which should be in neighbouring fields. Re-adjusting fence lines according to natural soil boundaries in most cases will correct this.

Of the land suitable for cultivation with restrictions and the land on which contour tillage should be practised, very little is wooded and only a small proportion pastured. The high proportion of these classes that are tilled can be maintained, but a good deal more attention could be paid to erosion and water loss control. The land suitable for cultivation with restrictions (LR) carries 20 per cent of the total pasture and the drainable land (LD) carries 30 per cent (Table A). The land designated as suitable only for pasture (P) is only 3.9 per cent of the whole area and it is obvious that demands for pasture far exceed this proportion. Therefore it can be concluded that lands of higher capability will carry some pasture. The drainable land can continue to carry a good deal of it and any further drainage projects should be carried out with this in mind. The LR land can meet demands for pasture and at the same time serve good conservation purposes if it is seeded to pasture with occasional cultivation. This can be achieved by very long rotations or what the British call "ley" farming. Some tests should be run to determine the longevity of pasture and proper methods of management so that the most can be made of this type of land.

There is forest cover on only 6.9 per cent of the land, yet 15.5 per cent of the land is really suitable only for forest. Quite a bit of land now under pasture or even

cultivated should have forest established on it, either by plantation or by natural regeneration. Further, existing woodland should have grazing excluded from it. This would increase the demand for production from the existing pasture. There is no doubt that, if all the land now used or potentially useful for pasture were brought up to the standards of production of the best managed pastures in the area, the carrying capacity of pasture on the watershed would be increased many times. It is hard to say exactly how much; some demonstration pastures carry as much as four times what unimproved pastures carry, so that it is not too much to expect that pastures could be made to produce, on the average, twice as much as they have been producing. Thus, any loss of area of pasture because of forestry can more than amply be made up by increased production on pasture.

4. Can Use Be Adjusted To Capability?

From the foregoing discussion the answer to this question would appear to be yes. The problem is how to do it. This will be discussed more fully in the next chapter. Briefly, the solution lies in two kinds of actions. First is the planning of individual farms to make each field, the crops on it and the system of management fit the natural conditions of the soil. This is "Farm Planning". The second may be called "Regional Planning" and will be effectuated not by individual operators but by public bodies and businesses which determine public policy of land use in any way.

CHAPTER 8

A RECOMMENDED CONSERVATION PROGRAM

1. Purpose

The aim of a conservation project has been repeatedly stated throughout this report to be the use and management of land according to its natural characteristics. The inventory of soil conditions given in the preceding chapters and in the accompanying map should be an adequate guide in formulating a plan. The inventory of land use and the descriptions of regions given in Chapter 6 provides a good enough picture of the present situation to indicate what changes, where necessary, are to be made. Enough is known of the ravages of soil erosion, fertility depletion and the methods of checking them to indicate the remedial measures necessary that need to be applied.

2. Demonstrations on Individual Farms

It is recognized that most of the work necessary to control erosion and water loss will be done by the farmers who occupy most of the land of the watershed. It is also recognized that the most effective way to introduce new ideas and methods is to demonstrate them on working units similar to other farms and right in the locality where farmers can see them. Therefore it is recommended that the Authority co-operate with existing agencies in establishing demonstration farms to show the application of farming methods designed specifically to control erosion and run-off.

Farms that have been planned for conservation now can be found on the watershed and the work on these farms is quite familiar to those who are interested in conservation and to a few others. It is now time to establish more of these farms so that every farmer on the watershed can see the same kind of operations.

It is recommended that demonstration farms be established according to the natural and economic regions outlined in Chapter 6 so that the farmers will see a demonstration on land which most nearly resembles their own with respect to soil conditions and type of farming.

3. <u>Farm Planning and Conservation Practices</u>

To operate a farm most efficiently and to incorporate all the necessary features of soil conservation into its management, a plan is necessary. A farm planning service is provided from the Soils Department of the Ontario Agricultural College through the Extension Service of the Department of Agriculture. This technical assistance is obtained by farmers by application through their county Agricultural Representative.

The first step in developing a farm plan is similar to the survey conducted on the whole watershed but is carried out in more detail. A map is prepared, using aerial photos as the base, of all the types and conditions of soil that are found on the farm. A map is also made of the present use of each field, the crop, its place in the rotation, wild pasture and so on. The capability of each natural division of the land is appraised according to what is known of each soil type, the extent of erosion and erosibility, determination of fertility and of any other natural limiting factors such as stoniness, droughtiness or lack of organic content.

A map of recommended use is drawn so that the existing fields, if necessary, are changed so that they conform to the natural conditions found on the farm. The use and the system of management of each field are indicated according to the natural classification. That is, for example, sloping land that is subject to erosion but on which erosion can be controlled by contour tillage and strip-cropping is marked out for cropping using those practices. Where

seriously eroded land should be reforested, where gully control is necessary or where grassed waterways should be established are also indicated.

With the land that is available for cultivation under a crop rotation, particularly that on which strip-cropping is recommended, the system of rotation is worked out so that each year there is a constant acreage of grain and fodder to carry whatever herd it is found that the land can support.

The change from the present use to the recommended use may be quite radical and could not be brought into effect within a year and a change-over period is arranged. It may be necessary, in some cases, to change fence lines, particularly where long strips are necessary for strip-cropping. Arrangements are made to make these changes progressively as the change-over is brought about.

This type of plan is especially necessary where there is a lot of land of the type which in this report is indicated in class CF or where it is necessary to establish woodlots, grassed waterways and diversion channels. On farms where there is mostly that type of land which is susceptible to erosion but it is not controllable by contour cultivation, there is not necessarily any reason to move fence lines or rearrange fields. A conservation system of farming calls for rotations to be worked out which will expose the land as little as possible to erosion and maintain the emphasis on soil-building crops. There may, however, be scope for certain individual remedies such as grassed waterways, or diversion terraces and buffer strips to break up the slopes. There may also be individual cases of gully stopping, reforestation, improved woodland management or pasture improvement which can be carried out on fields and farms as they stand now without any radical change in the farm set-up. These can be proceeded with directly by the farmer; but where it involves practices

and methods with which he is not familiar he should avail himself of whatever technical assistance there is.

Most of the things that are considered to be "conservation farming" can be done by the farmer with his own equipment. There are some things, however, which may require special equipment or heavy implements that every farmer does not possess. An example of this is the earth-moving or grading equipment necessary for some gully stopping, grading grassed waterways or constructing farm ponds. The Authority could serve a very useful function if it made equipment of this sort, and technical advice, available to co-operators. It might be convenient to enlist a group of co-operators in one district who have the same problems and concentrate on one or more features such as gully stopping or grassed water-courses. As one group of farmers become familiar with these practices they should be able to help out neighbors who have projects that can be handled with ordinary farm equipment.

There is some literature available on these subjects from the Provincial and Federal Departments of Agriculture. One particularly is recommended - Grassed Waterways (Ontario Department of Agriculture, 1950). Various bulletins issued by the U. S. Department of Agriculture describe conservation techniques in detail. There are a number of good textbooks available, notably those by Ayres, Gustafson and Bennett[1].

Actually new methods are better learned by demonstration, and technical advice is available from the extension service carried on from the Agricultural College. Many of the implement manufacturers have handy bulletins on contour cultivation, terracing and pond construction and should

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1. Ayres, Q. C. Soil Erosion and Its Control. McGraw-Hill. 1936.
   Gustafson, A. F. Conservation of the Soil. McGraw-Hill. 1937.
   Bennett, H. H. Elements of Soil Conservation. McGraw-Hill. 1947.

be able to demonstrate the use of their equipment as they do at Grassland and Wheatland Days or as was done on the Heber Down Farm at Brooklin, Ontario, in 1949. A conservation field day comparable to a Grassland Day might be arranged to show off some of these methods.

4. <u>Grassland</u>

Examination of the map of recommended land use according to use capability which accompanies this report will show how significant is the question of improved grassland. It might be said that this is the biggest single measure in soil conservation, whether it is considered from the point of view of area or of total production. The Grassland Day held at Woodstock in 1950 had as great significance to conservation as anything else that has ever been done.

Grass is both the biggest source of production of beef and milk and the surest way of building soil and resisting erosion. It might be said that if all the land on the watershed which is indicated as suitable for grassland, either in permanent pasture or in long rotations, were cultivated, fertilized and seeded to improved mixtures and were carefully managed with respect to clipping, fertilizing and grazing rotated, that there would be more grasses and legumes produced than could be used for grazing and for making hay. An answer to this question is the use of grass and legume silage. Those who are concerned with the technical problems of making and storing silage may not yet be convinced of its great value. Possibly some capable producers who pride themselves on their animal feeding may dispute its value. But those who have gone over to this type of farming, especially on land particularly suited to grass, are wholehearted in their support of the practice. To those who have considered the economic problems of setting up a farm these days, particularly the administrators of the Veterans Land Act, the idea of wintering a herd on grass silage is very attractive.

To all those who are advocating greater use of grass silage can be added those who are interested in soil and water conservation.

5. Drainage

Over 30 per cent of the soil on the watershed is inadequately drained naturally for the production of the full range of crops used, particularly alfalfa and winter grains. A higher proportion of these soils is cultivated than the average. Obviously, much of the area has been artificially drained to some extent to make this use possible. As land use becomes intensified, as it is likely to be with the growth in population of the Province, further artificial drainage can be expected.

In the conservation of water particularly there is some dispute as to the advisability of more drainage, and a Conservation Authority is especially concerned in the matter even though its powers may be limited in this respect.

Opposition to drainage is based, it would seem, more on ill advised, ill constructed and poorly managed drainage schemes than on any fault in drainage as an agricultural practice. In the procedure for carrying out drainage schemes there is no provision for even the advice of a soil expert or a trained agronomist. If proposed drainage schemes were reviewed from the point of view of whether the soil needed it or whether they were required for the cropping schemes on the land the decision to drain would be better supported.[1] The thousands of acres in Ontario which now carry willow scrub or poor wetland pasture with old but expensive drainage ditches going through them are mute evidence of the inadvisability of many drainage schemes. An anomaly in the

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1. Report of the Select Committee on Conservation. Ontario, The King's Printer, 1950.

administration of the drainage laws is often seen in awards on the basis of the land drained by the ditch regardless of whether the soil actually benefits from artificial drainage. Indeed, cases might be cited of the presumed beneficiary suffering from loss of water.

Many individuals are involved in the building of a drainage project, the petitioners, the municipal council, the engineer, the referee and whoever puts up the money for the job. Once a petition is accepted by council, work is proceeded with on the assumption that the project is a worth-while venture and there is little question of any other implications, what it does to the water relations of the area, stream flow and groundwater levels, or the ultimate total effect it will have on land use. Under present legislation the Conservation Authority is at least aware of what is proposed and can make it its business to study these other implications and use whatever influence and powers it has to inform and guide public policy in the matter.

The ill effects of drainage schemes are most noticeable locally and the accelerated run-off in a ditch may produce local flooding, especially where the ditch, being straight, has facilitated formation of an ice jam which, when it breaks, releases a flood peak. When a number of tributaries deliver their flood flows at the same time there may be flooding on a main stream.

It is ironic that areas which are drained artificially may suffer from drought in summer and even have a shortage of water supplies. If drainage were considered as "redistributing" water, and provision were made to hold part of the surplus flow for later use, rather than merely a process of "getting rid of the water", artificial drainage would appear in a better light.

Because a large proportion of the soils of the watershed require artificial drainage to improve agriculture and because further drainage works can be expected, it is

recommended that the Authority, through a committee appointed for that purpose, watch closely, and influence where it can, policy and administration of drainage schemes.

6. Land Use Policy

Although the farmer is considered as the one who determines what use is made of the land and how it is to be managed, a little reflection will show that land use is actually controlled by many other people. The three main groups which influence land use are the agencies that extend credit to the farmer for his property, his improvements and his operations; the firms that supply him with his equipment, seed, fertilizer and materials; and the marketing agencies which buy his produce. A further control is in the governments which tax him and which, by systems of tax concessions and marketing aids, can induce him to apply his land to certain uses.

All these groups are as much interested, if not more, in sustaining not only the productivity of the land but the welfare of the whole community of which the farm is a part. It is conceivable, then, that without compulsion or control land use can be planned in such a way as to protect the soil and water, in short, to achieve the aims of conservation, "the wise use of all the land, for all people, for all time".

A few examples can illustrate this point. Take the case of cash cropping. The farmer may operate with short term credit or under contract from a processor who handles his product. If the farmer can clear himself of all debt and make a profit in a few years he has acted wisely. But if the land after a few years is no longer able to carry cash crops, and may be even too worn down or eroded to support mixed farming, the contractor or creditor has lost a customer in whoever occupies the land.

If the manufacturer who sells implements continues to sell tillage and harvest machinery to produce grain in an area which is susceptible to erosion, he may find himself eventually without customers (unless he changes to selling tree-planters). But if he studies the area and pushes the sale of implements for harvesting grass, a prosperous agriculture based on the natural capabilities of the soil is more likely to persist indefinitely.

Any marketing agency, private or co-operative, presumably expects to stay in business indefinitely and it is to its advantage to sustain the productivity of the land for all time. In addition to all the other technical services that such an agency may advance to its subscribers with respect to grading, packaging, fertilizing, spraying and so on, advice on the conservation of soil and water would be to the advantage of both the producer and the agent who distributes his goods.

For the most effective action in planning land use there must be some central agency whose interests cover all phases of land use to co-ordinate the gathering and dissemination of knowledge and the framing of policy. No body could perform this function better than a Conservation Authority and they now have the machinery for doing so in their Advisory Boards. It is therefore recommended that the Authority facilitate conferences of representatives of producers, financial houses, supply businesses and marketing agencies of agricultural produce within the watershed to discuss ways of shaping land use in accordance with conservation principles and what is known of the physical characteristics of soil and water resources.

7. Credit and Land Tenure

That the soil has been required to produce more than it can safely yield from year to year is not necessarily the fault of the farmer or of those who have

been before him on the land. Whether owner or tenant, the operator has certain financial commitments to meet from year to year. To remain in possession and in operation he must meet these and he must use his land in such a way as to yield the necessary cash return. This is the reason for a good deal of the erosion and soil depletion which has gone on in the past. In the United States, where the problem of soil erosion and depletion and drought has been dealt with systematically for some years, this is recognized. Steps to correct it have been taken, not only by governmental bodies but by financial houses, in so far as their system of banking allows the extension of credit on land. The American attack on the problem merits close study. It need not be necessary to adopt their financial machinery nor revise our own to meet the situation. What is required is to study how our system of land tenure and financing can be accommodated to take into account conservation of our resources as much as they do prices, markets and all the other factors which influence the money market. It is recommended, therefore, that the Authority, through its Forestry and Land Use Advisory Boards, bring the inventory of resources that is given in this report and its maps to the attention of those who have a financial interest in the sustained productivity of the land.

Operating of farm land by leasehold tenants is generally looked on with disfavour as alien to the traditions of our country. In view of the rising cost of capital outlay to undertake operating a farm it is quite possible that tenancy may increase, that is, more people will be able to find enough money to equip and stock a farm, and rent it, than will be able to stock, equip and establish an equity in a farm. In older countries where farming has been carried on in this way for generations it has been common practice to write covenants into leases requiring certain specific land use practices to maintain the fertility and

tilth of the soil. It is recommended, therefore, that the Authority explore, with competent legal advice, the possibilities of establishing soil conservation practices by using covenants in leases on farm properties.

With respect to cash cropping which may erode land and aggravate soil problems the only direct action the Authority can take is to acquire land for reforestation. The only other way in which harmful cash cropping, particularly tobacco, could be excluded from water-storage areas in swamps and from land susceptible to erosion is by passing zoning by-laws for areas to be protected. This need not conflict with the interests of producers, for there is ample land that is not vulnerable to satisfy foreseeable demands for special types of soil.

8. Forestry and Recreation

Acquisition by the Authority of land for these uses is described in other sections of the report. There is, however, a large acreage of land suitable for tree plantations or for woodland improvement remaining on farms. The Authority can assist farmers in reforestation and might enter into co-operative management of existing woodland, extending to the operator, not only technical assistance, but some material help in fencing and in arranging orderly and profitable marketing of his wood products.

CHAPTER 9

FARM PONDS

1. Inventory of Ponds

All the existing ponds were visited to find out as much as possible about building ponds on the watershed. On the basis of what was actually found and comparing this information with what is known of the types of land, a map of "Recommended Regions" was prepared. On this are indicated the regions most suitable for each type of pond.

Ponds that are actually being used on farms are of five types. These are: natural ponds, dug-out ponds, spring-fed ponds, by-pass ponds and ponds formed by dams. They had a variety of uses. Fire protection and stock watering are the main uses, but fishing, swimming and irrigation are not uncommon uses and some have been built for property beautification.

The existing ponds are in various states of repair and only a few can be considered to be properly managed. Ponds naturally silt in if not protected. They suffer most from trampling of cattle. A well managed pond should be fenced and a pipe or some other method used for drawing off water for stock.

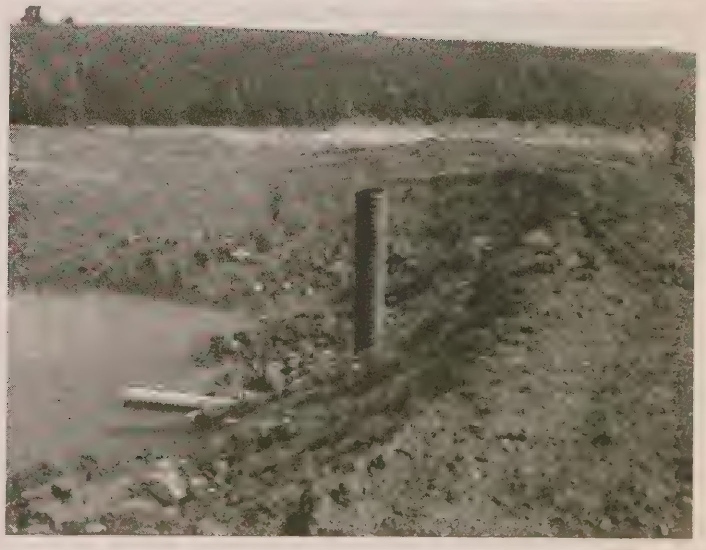
Of the 216 ponds examined on the watershed, 62 were natural ponds, 139 dug-outs, 8 spring-fed, 1 by-pass and 6 formed by dams. For the distribution of the different types according to land types see the accompanying map.

2. Relation Between Existing Ponds And Land Types

It is obvious that certain types of land are particularly well suited to ponds of certain kinds. Where ponds are lacking it is difficult to say whether it is because no need has been found for ponds or whether the land has not been suitable.

Dug-out ponds like this one near Elginfield are common in areas with ground water near the surface.

A well managed spring-fed pond north-east of Stratford.



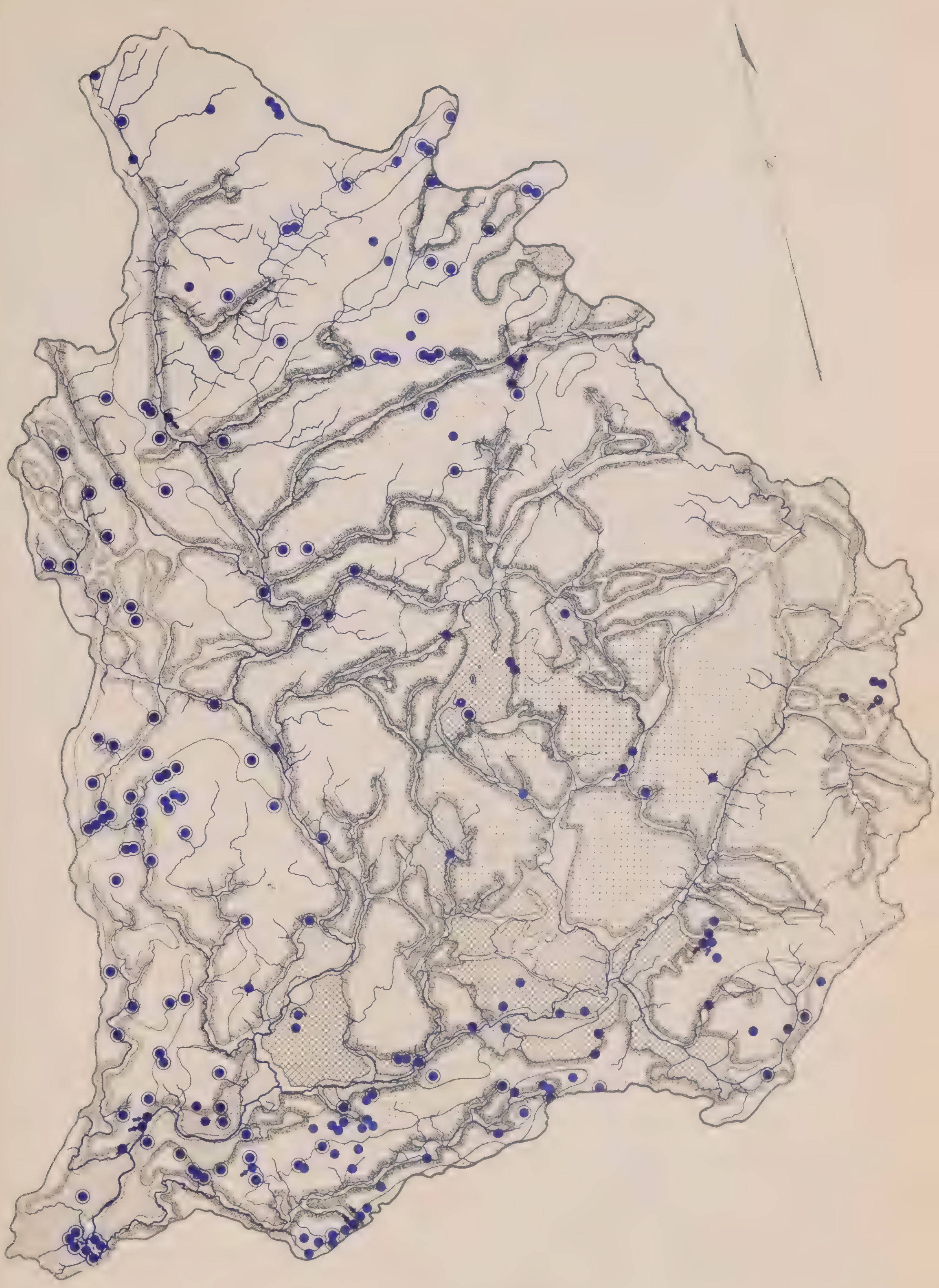
A run-off pond under construction north of Beachville. Note the clay dam to the right, emergency spillway in the background and drop inlet discharge pipe in the middle.

The commonest type of pond is the simple dug-out, and these are found especially on two types of land. First, the wetter locations on the undrumlinized till plain. It is characteristic of this land type to have a poorly established natural drainage system and on the low spots the water table reaches the surface. The same condition is found on the clay moraines which have irregular topography and numerous wet hollows. Natural ponds are found in the same locations and also on the flat valley bottoms or spillways where water lies in pools or can be found easily by simple excavation.

Ponds that require definite construction only totalled fifteen, and only one was found on the drumlinized till plain. This is remarkable because it is on this type of land that the most prosperous agriculture is to be found. It would appear that up to the present no particular need for ponds has been felt, but it would seem that this type of land would lend itself particularly to pond building by damming watercourses. The soil on this land type is fairly permeable and in the past farmers may have found that ponds do not readily hold water, but on similar situations on other watersheds, possibly where people are more "pond conscious", ponds have been found.

The commonest type of artificial pond is that which is fed from springs. These are not found on the kame moraines, probably because the soils are too permeable, and only one was found in a spillway. These permeable soils often have springs along the margin, between them and the less permeable soils.

A very useful type of pond, because it is so simple to build and has such a small risk of being washed out or silted in, is the by-pass pond, but only one of these was found. There are six ponds formed by damming, mostly on permanent streams, although they can be built on intermittent watercourses where they are certain to be filled during the spring run-off and on many occasions may be re-filled during summer storms



FARM PONDS

EXISTING FARM PONDS

- DUG-OUT
- DAM ON PERMANENT STREAM
- SPRING-FED
- BY-PASS
- NATURAL

RECOMMENDED REGIONS

- TILL PLAIN-DRUMLINIZED Suitable for all types
- TILL PLAIN-UNDRUMLINIZED Suitable for all types especially dug-out.
- TILL MORAINE Suitable for all types especially runoff
- KAME MORAINE and SAND PLAINS Less suitable permeable soil
- SPILLWAYS Less suitable-May have by-pass ponds or permanent dams where bottoms are impermeable
- ESPECIALLY Suitable for spring-fed ponds on edges of kame moraines and spillways.

3. Recommended Regions

The accompanying map shows both the existing farm ponds and the regions that are recommended as particularly suitable for certain types. It is recommended that as demonstrations are set up this regional distribution be followed so that farmers will see examples of the type that they will most likely build themselves. Providing a suitable impermeable bottom can be found, the drumlinized till plain should be able to carry any type, according to the available supply of water. The type of pond called the "run-off", which is not listed here, but which is commonly referred to in literature on ponds, might be established by putting earth dams across intermittent watercourses which drain sufficient land to give the necessary run-off. In New York State, where the climate is not unlike that of south-western Ontario, this type of pond is commonly built, even though it is only filled by meltwater in the spring of the year.

On the undrumlinized till plain in the north-western part of the watershed, the commonest type is the dug-out pond; and although other types might be built, and there is no question regarding permeability of the soil, the dug-out type should be the commonest.

In the regions of till moraine all types might be built but special attention might be paid to the run-off types as the country is generally rolling and provides many suitable small watersheds to feed ponds by surface run-off.

The kame moraines and sand plains are considered less suitable for ponds because soil is so permeable that the pond may not hold water, nor an earth dam be entirely reliable.

On the flat valley bottoms and plains indicated as spillways on the physiographic map, ponds are less certain of success. This is because the gravelly and silty soils are so permeable to water. Small streams might be drained or excavations at the side may be made for by-pass streams, but if this is contemplated investigation must be made to establish

that there is an impermeable clay bottom on which the pond may be sited. For this purpose an extendible soil auger which will bring up samples from ten feet can be used. It will be seen that the map of recommended pond regions closely resembles the physiographic map given in the introductory general section of this report. There is one addition, that is the shading of areas which mark the boundary between permeable (sandy and gravelly) soils and impermeable soils. Springs are common in these zones, and if the pond can be sited on the impermeable soil, then these are very likely spots for building.

4. Building Farm Ponds

A farm pond might be defined as a surface reservoir of water with a natural supply to be used for farm purposes and to cost no more than what a farmer would be prepared to pay for either a main or supplementary (or emergency) supply of water.

Farm ponds have two purposes - first is to serve the farmer on whose property they are built. The second purpose is only achieved if a great many ponds are built. That is, it is believed that a multitude of small ponds will help to conserve moisture in the soil, and in the case of ponds formed by dams, help, each in their small way, to control the flow in the streams.

A bulletin describing the main features of pond building is available from the Conservation Authority. This is only a guide and does not presume to give specific instructions for each individual pond. This pamphlet, along with the information given with this report and map, should be helpful in a general way by actually selecting the site, and constructing the pond should be undertaken only under the direction of a person competent to make the decision. As pond building becomes more common, farmers and contractors should become more familiar with the details of constructing ponds in each locality.

Because ponds are of value to the whole watershed as well as to the individual farmers, it seems only right that a program of pond building should have the support of the Conservation Authority and the program is getting that support in provision of some technical help in constructing ponds. It is recommended that the Authority continue to carry out this project.

FORESTRY

CHAPTER 1

THE FOREST

1. At the Time of Settlement

Looking at the woodlands of the Thames Watershed today, one feels like the archaeologist who discovers a few bones of some prehistoric monster and from it strives to create a picture of what the animal was actually like in its native environment. In the case of the forest in Southern Ontario, we are somewhat more fortunate than the archaeologist in that we have the works of contemporary writers to help us in reconstructing the scene, and from these we are also able to learn the reasons for the animosity of the pioneers to this great, oppressive and fearsome thing which overlay the good earth and must be hacked, slashed, beaten down and burned if they themselves were to survive.

Anna Jameson[1], travelling by stage coach from Toronto to Detroit in 1837, gives the following picture of the forest between Brantford and Woodstock as seen through the eyes of a visiting Englishwoman:

> "No one who has a single atom of imagination can travel through these forest roads of Canada without being strongly impressed and excited. The seemingly interminable line of trees before you; the boundless wilderness around; the mysterious depths amid the multitudinous foliage where foot of man hath never penetrated, and which partial gleams of the noon-tide sun, now seen, now lost, lit up with a changeful, magical beauty...the solitude in which we proceeded mile after mile, no human being, no human dwelling within sight."

Later on she gives a vivid sketch of the typical clearing:

> "The aspect of these was almost uniform, presenting an opening of felled trees of about one acre or two...great heaps of timber trees and brushwood laid together and burning; a couple of oxen dragging along another enormous trunk to add to the pile. These were the general features of the picture framed, as it were, by the mysterious woods."

At one place she stops and chats to a settler

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1. Winter Studies and Summer Rambles in Canada - Anna Jameson, 1837.

who has one hundred and fifty acres of land of which he has cleared five to six acres in the past five years. He tells her, "You may swing the axe here from morning to night for a week before you let the daylight in upon you".

The settler's aim was to eliminate the trees, for they interfered with all his works of farming, road construction and town-site development and he attacked them with every means in his power. Anna Jameson describes a ghastly sight on the road between Hamilton and Brantford:

> "I remember a stretch of about three miles on this road, bordered entirely on each side by dead trees, which had been artificially blasted by fire or by girdling".

and remembering the park-like estates of her own land expresses her feelings thus:

> "I cannot look with indifference, far less share the Canadian's exultation when these huge oaks, these unbrageous elms, and stately pines, are lying prostrate, lopped of all their honours, and piled in heaps with the brushwood to be fired, - or burned down to a charred and blackened fragment - or standing, leafless, seared, ghastly having been girdled and left to perish".

Not all the forest was dense and dark, however; the Indians originally cultivated the bottom lands, notably at the confluence of the North and South Branches of the Thames. Mrs. Jameson also describes more open types of forest:

> "Oxford, or rather Ingersoll, where we stopped to dine and rest previous to plunging into an extensive pine forest called the "Pine Woods"... The forest land through which I had passed, was principally covered with hard timber as oak, walnut, elm, basswood. We were now in a forest of pines, rising dark and monotonous on either side... These seven miles of pine forest we traversed in three hours and a half; then succeeded some miles of open, flat country called the oak plains and so called because covered with thickets and groups of oak dispersed with park-like and beautiful effect..."

Major Littlehales [1], returning with Governor Simcoe from Detroit to Niagara in 1793, describes the site of the future City of London as follows:

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1. A short, topographical description of His Majesty's Province of Upper Canada. D. W. Smith. 1799.

> "A pinery upon an adjacent hill knoll, and other timber on the height well calculated for the erection of public buildings...We ascended the height at least one hundred and twenty feet into a continuation of the pinery already mentioned, quitting that we came to a beautiful plain with detached clumps of white oak and open woods. Then crossing a creek running into the South Branch of the Thames, we entered a thick swampy wood."

The woods of Oxford County were described in 1876 [1] as follows:

> "In its primitive state the towering pines of Blenheim had fellowship in those of Norwich and Dereham (Townships) while the maple leaf was seen in richest luxuriance in the Oxfords, Zorra and Nissouri (Townships)."

Similarly of Perth County it was stated:

> "Parts of the County [2] - particularly in the townships of Ellice, Logan and Elma abound in swamps of considerable extent, so great in fact, that until within comparatively few years the great morass known as the "Ellice Swamp" and covering many thousands of acres seemed to defy the efforts of man to subjugate it, so far as to make it habitable territory or even to penetrate it, in parts with ordinary highways...Perth occupies the height of land of Western Ontario, two branches of the Thames as well as the Maitland and the Nith (Rivers) rise here."

These early descriptions indicate that the original forest was predominantly hardwood with a sugar maple - beech cover type which, with associated southern hardwood species, occupied the best soils. Soft maple and elm occupied similar but poorly drained soils on the higher land, particularly on the heights of land between watersheds. Oak, in open park-like groupings, held possession of the sand plain while scattered white pine trees towered above the hardwood forests and grew in stands on well drained loam soils. White cedar and mixed woods of white cedar, hemlock, white pine, soft maple and yellow birch grew on the muck areas.

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1. Topographical and Historical Atlas of the County of Oxford, 1876.

2. Illustrated and Historical Atlas of the County of Perth, 1879.

The suitability of the greater part of the soil of the Thames Watershed for cultivation and the inimicable attitude of the settlers to the forest led to a very rapid depletion of the woods, and the swing of the pendulum carried the clearing of them past the bounds of economic necessity and past the point which would have left the minimum area of woodland required to protect the natural water-storage areas of the watershed.

2. Since Settlement

The attitude of the early settlers to the forest was completely hostile, as has been shown, which feeling was very natural because the forest was undoubtedly the greatest obstacle to the economic development of the land. Part of the animosity may have been engendered, too, by the fact that, not so many years previously, the forest had sheltered the native Indians who had harassed the homesteads farther east. This ingrained antagonism became a sort of vendetta which has only begun to disappear in comparatively recent years.

When a new area was opened for settlement the best land was naturally taken first and the rough and swampy areas were avoided. Land was usually cleared first along the fronts of the farms and the woodland cut farther and farther back toward the end of the farm which lay farthest from the road. This was done, in many cases, without reference to the quality of the soil except where it was swampy, with the result that the majority of woodlots now lie at the back of the farms between the concessions.

The land bordering swamps was eventually taken up, the swamps were partially drained so that the edges became dry enough for partial cultivation, and the forest was pushed back so that today the centres of the swamps form the nuclei of all the larger patches of woodland in the Thames Watershed. These swamps also form the largest natural sur-

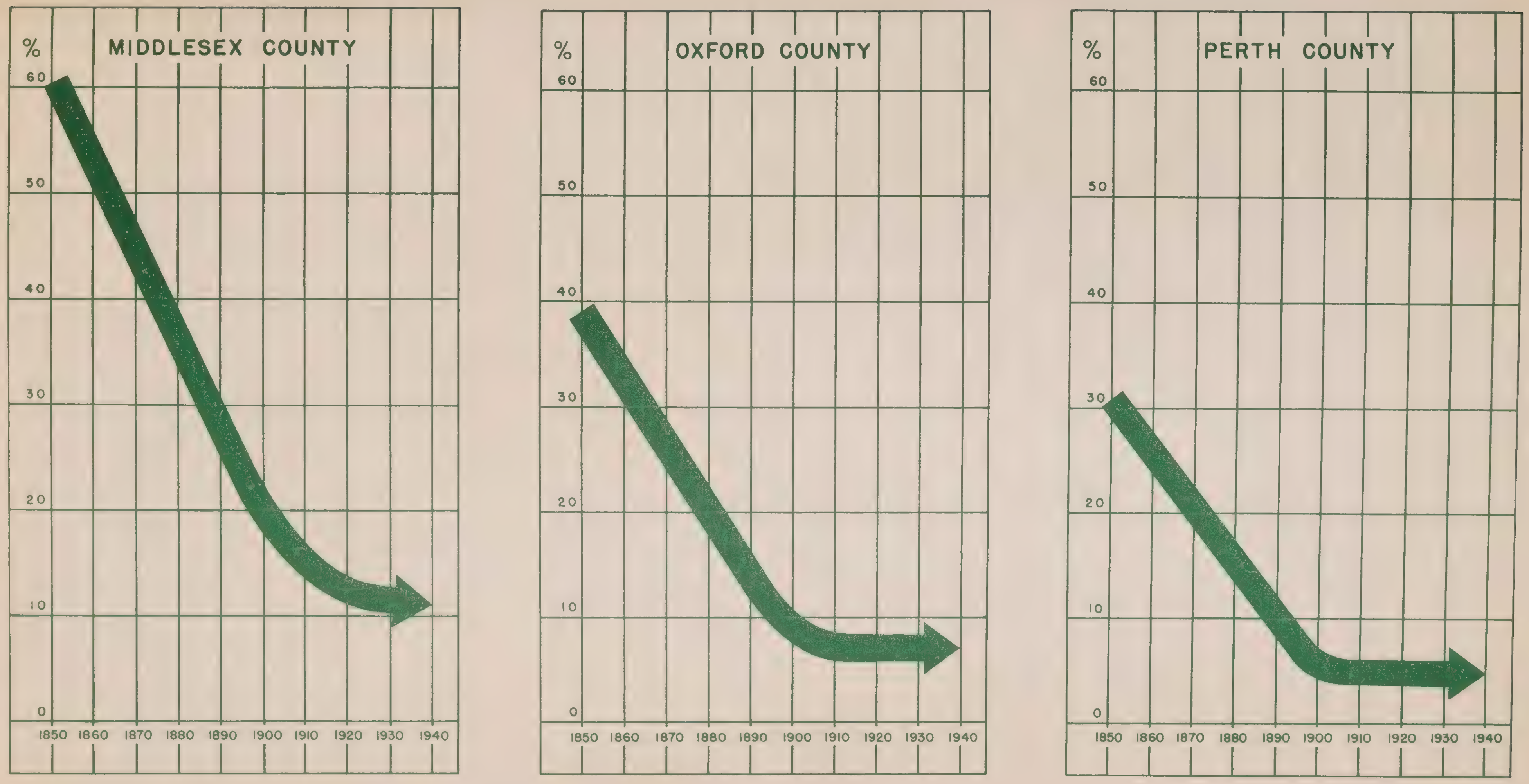
WOODLAND IN PER CENT AND ACRES ON OCCUPIED LAND

County	Township	1860		1890		1910		1920		1930		1940		Total
		%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	Area
	Biddulph	-	-	-	-	6.4	2,252	5.7	2,000	6.9	2,431	3.8	1,337	35,328
	Dorchester N.	38.5	19,441	16.7	8,460	7.0	3,528	7.4	3,724	7.9	3,989	7.8	3,951	50,545
	Lobo	50.0	23,531	17.7	8,294	9.8	4,577	8.4	3,904	8.0	3,715	8.6	4,007	46,812
	London	46.0	43,740	13.4	12,650	5.6	5,268	6.8	6,431	6.8	6,448	6.4	6,025	94,158
	Nissouri W.	43.7	21,042	16.1	7,745	7.5	3,633	6.4	3,099	5.8	2,814	5.3	2,574	48,178
	Westminster	38.4	23,715	15.5	9,583	5.1	3,162	6.7	4,163	6.3	3,913	5.7	3,553	61,807
Middlesex		37.8	287,681	20.4	156,798	9.9	75,690	8.1	61,585	8.4	64,309	7.8	59,342	761,332
	Blandford	34.2	9,874	15.4	4,456	6.4	1,850	8.3	2,397	7.8	2,238	9.2	2,666	28,888
	Dereham	-	-	-	-	8.0	5,233	8.8	5,741	7.3	4,737	6.5	4,204	65,107
	Nissouri E.	43.1	19,903	13.1	6,043	8.5	3,943	7.5	3,463	7.2	3,320	6.8	3,144	46,371
	Oxford E.	35.9	12,103	14.3	4,820	5.6	1,874	5.4	1,821	5.9	1,995	5.4	1,813	33,795
	Oxford N.	49.1	10,443	11.5	2,457	6.2	1,319	6.8	1,451	6.5	1,375	6.1	1,290	21,268
	Oxford W.	35.0	9,187	8.8	2,301	5.0	1,307	7.3	1,916	4.6	1,230	4.5	1,178	26,225
	Zorra E.	36.6	21,086	12.0	6,938	7.9	4,556	6.7	3,866	6.0	3,476	5.5	3,197	57,696
	Zorra W.	45.7	25,917	14.5	8,217	7.9	4,508	6.8	3,879	7.9	4,473	6.5	3,678	56,727
Oxford		37.7	176,851	15.7	73,697	7.3	34,308	7.4	34,858	7.1	33,119	6.7	31,465	469,562
	Blanshard	51.6	24,294	10.7	5,060	3.7	1,751	4.6	2,158	4.4	2,074	5.0	2,340	47,172
	Downie	47.7	23,028	14.0	6,786	6.4	3,105	7.5	3,606	7.0	3,366	7.0	3,376	48,431
	Easthope N.	36.2	15,390	19.0	8,069	12.6	5,352	11.7	5,008	12.1	5,152	12.1	5,176	42,558
	Easthope S.	37.4	8,790	17.8	4,171	9.6	2,242	8.4	1,980	8.5	2,000	7.3	1,720	23,511
	Ellice	24.5	13,419	16.5	9,010	4.1	2,250	6.1	3,342	4.1	2,268	4.2	2,318	54,748
	Fullarton	46.6	17,933	18.0	7,463	8.2	3,414	7.2	2,990	8.5	3,541	7.0	2,897	41,554
	Hibbert	55.8	23,124	12.1	5,507	8.8	3,631	8.1	3,349	7.9	3,276	6.7	2,787	41,456
	Logan	34.6	18,587	14.7	7,928	3.1	1,657	3.7	1,962	4.6	2,453	4.0	2,171	53,767
Perth		46.3	241,519	14.6	76,140	6.6	34,377	6.7	35,140	6.5	34,099	6.1	31,749	521,106

face water-storage areas, and in many cases are the sources of headwater streams. Trees will grow here in most cases and are probably the most profitable crop which can be raised, especially since they perform the additional function of protecting the source areas from too rapid run-off.

Although settlement did not begin until the early part of the nineteenth century and the forest was almost unbroken along Governor's Road for miles west of Ingersoll as late as 1837, so rapid was the reduction that by 1860 the forests of Middlesex and Oxford Counties were depleted by more than 60 per cent, by 1910 by more than 90 per cent, and by 1940 the Census of Canada showed woodland figures for the counties embodying the Thames Watershed above London to be: Middlesex 7.8 per cent, Oxford 6.7 percent, Perth 6.1 per cent.

The accompanying table shows the rate at which the forests were cut rather than the actual areas of woodland remaining at the dates shown, because the definition of woodland varies with the individual person. For instance, a farmer may consider cut-over land which is used as pasture to be pasture, while the forester may consider similar cut-over land, on which the reproduction is good, as potential woodland and records it as such. The actual measurement of woodland in the Upper Thames Watershed made in 1950 shows a total of 57,025 acres or 6.7 per cent.



PER CENT WOODLAND

CENSUS OF CANADA FIGURES

CHAPTER 2

FOREST PRODUCTS

Because the forests of the Thames Watershed were predominantly hardwood and settlement came later than in the counties farther east, the pattern of history of the forest products is somewhat different from that of other parts of Ontario.

All the timber taken out for export had to travel first westward down the Thames and then eastward through the Great Lakes to reach the seaport; consequently comparatively little of it was exported to Britain though large quantities went to the United States. Softwood timber was never abundant and most of it was required for local use[1], also the building of ships for the lakes trade soon became a thriving business, notably at Chatham, and this absorbed a great deal of timber. For these reasons the masting and square timber trades were never as large as in many other parts of Ontario, though very considerable quantities of oak were exported as square timber. On July 5, 1837, Anna Jameson writes: "The Thames is very beautiful here, and navigable for boats and barges, I saw today a large timber raft floating down the stream, containing many thousand feet of timber".[2]

In the March 18 issue of the St. Mary's Argus of 1858 it was stated that "an immense quantity of cedar posts, rails, hewn timber passed down the river today" and again on March 17, 1881, "At the present rate of consumption

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1. "In the London and Western Districts (of Upper Canada)... there are not more pine and cedars than suffice for building materials and fencing timber for home consumption. Indeed there are several townships in the Western District entirely destitute of pine timber ... a circumstance ... attended with many serious inconveniences." E. A. Talbot. Five Years' Residence in Canada. 1824.

2. Anna Jameson. Winter Studies and Summer Rambles in Canada. 1837.

the standing hardwood of this country will last only twenty years longer". How true this latter statement was is borne out by the tables.

1. Early Policy

Previous to 1826 the only persons authorized to cut timber on the public lands were the contractors for the Royal Navy, or those holding licences from them, and there was great infringement of the regulations and much illicit trade. But in this year the first steps toward making the forest resources a source of revenue to the Province and "so securing to the public a share of the wealth drawn from the public domain" led to co-operation among the officials and the termination of the contractor's monopoly. The inauguration of a system under which anyone was at liberty to cut timber on the ungranted lands of the Ottawa lumber region on payment of a fixed scale of rates to the Crown overcame in large part the annoyance of the people and authorities in the colony against the export of the sound Canadian timber for the British Navy.

2. Masting

The selection of mast timber was made by government agents who went through the forest blazing with a broad arrow - the mark of the British Government. As late as 1827, when Peter Robinson was appointed Surveyor-General of His Majesty's woods and forests in the province of Upper Canada, he was instructed "to make a survey of the districts where there may be any considerable growth of masting and other timber fit for the use of His Majesty's Navy".

The mast and spar export to Britain was thriving in the thirties and forties and it was continued intermittently as late as 1855. The British trade dropped off noticeably after 1854 and this may be attributed to the Reciprocity Treaty with the United States in that year, "securing the free exchange of the natural products between Canada and the United

States, including timber and lumber of all kinds, round, hewed, and sawed, manufactured in whole or in part", and the building of railway connections with the United States border cities.

3. Square Timber

The square timber trade commenced, no doubt, somewhat later than the mast trade and was carried on simultaneously with it from the thirties.

Square timber was obtained by selecting large trees, mostly white pine, and squaring the best part into one long stick. In the earliest days of the industry the timbers were squared on all four sides to a fine "proud edge", but later, when the best timber had been cut, they were squared with a rounded shoulder or "wane", and were known as "waney timber". Such methods, of course, were wasteful since the finest grained wood was sacrificed in the operation, but this was the type of material called for by the British market.

> "Often only one tree in a thousand would yield a finished 'stick' (so was the heavy square timber nonchalantly called in the trade) fit for export. A good stand might yield thirty or forty trees an acre for over the whole area allowances had to be made for 'wants' - the non-bearing patches of swamp, burn, etc. Today a whole township or limit (in Northern Ontario) may not have one good square stick of the quality of the square timber of another day."1

The timbers were transported by the river, by teams or by railway to the lake and were built into huge rafts on which the lumberjacks built shanties and lived during the trip down to the timber coves at Quebec.

4. Saw Material

From 1800 on the cutting of timber had been one of the most important domestic businesses in most parts of Southern Ontario, and a very considerable business was carried on.

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1. A Hundred Years A-Fellin', 1842 - 1942. Gillies Bros. Ltd. 1942.

FOREST PRODUCTS OF FARMS - CENSUS OF CANADA FIGURES - MIDDLESEX COUNTY

Product	Species	Unit	1870	1880	1890	1900	1910	1920	1930	1940
Pulpwood		Cords			12					
Tanbark		Cords	412	322	668	29				
Lathwood		Cords	285	1,984	50,164					
Masts & Spars		Number	10	338		2	4			
Staves		Thousands	2,112	1,960	5,810	3,627	923			
Fence Rails		Number						21,542	845	
Fence Posts		Number			84,253	20,100	4,891	18,531	13,426	
Poles		Number			118	264	225	501	110	
Railway Ties		Number			21,429			321	150	
Square Timber	Ash	Cu. Ft.				9,153	2,220			
	Birch	"				120				
	Elm	"			88,561	137,709	85,036			
	Maple	"				12,652	9,295			
	Oak	"	272,041	481,727	32,146	12,855	5,042			
	Pine	"	7,378	31,740	7,920	220	300			
	Others	"				12,747	6,040			
Logs (Lumber)		Number						39,516	956M	
Logs Softwood	Pine	Cu. Ft.	16,452	22,322	81,790	341M	446M			
	Others	"	35,295	130,624	129,193					
	Spruce	"				13M	2M			
Logs Hardwood	Tamarack	"	37,598	36,765	3,160					
	Oak	"				499M	373M			
	Maple and Birch	"	8,520	13,021	15,440					
	Elm	"	299,782	215,968		10,028M	1,765M			
	Black Walnut	"	7,582	2,968	1,042					
	Butternut	"	13,440	295,928	800					
	Hickory	"	19,040	42,022	15,201	119M	24M			
	Others	"	221,104	287,115	150,611	2,766M	3,085M			
	Hemlock	"				102M	27M			
Fuelwood		Cords	256,712	267,756	233,266	182,878	95,113	112,923	78,790	47,230
Other Products		Value $						482	672	23,618

M = 1,000 feet board measure

In order to convert logs into boards the first method used was pit-sawing. This was sometimes done on the bank of the river, as such procedure saved the necessity of digging a pit.

The more usual methods of pit-sawing appear to have been the digging of a pit or building of a platform with a simple but firm and strongly constructed framework. In either case the framework was made the right height for one man to stand underneath, while the other man stood above on the platform or astride the log. This hard method of sawing timber was laborious, and twenty-five boards were a heavy day's work for two men; the boards were nearly always one inch thick, with planks two inches, and the occasional flooring one and a half inches in thickness.

The first power saws were a direct development of the manually operated pit saw. These were called frame, upright or muley saws and consisted of a saw set vertically in a wooden frame and moved up and down by means of a crank connected to the shaft of the water wheel.

> "Wherever a settlement is formed in America a sawmill is very soon after, if not at the same time, erected. The number of sawmills in the British Colonies are inconceivable to those who are not familiarized to the rising settlements of new countries.
>
> "A sawmill is in fact a most important establishment. It not only forms a nucleus or centre to a settlement, but a first-rate sawmill, with two frames, will give employment to four first-rate, four second-rate and two third-rate sawyers, besides a measurer, a blacksmith and from thirty to forty men to prepare the timber required and for other requisite work connected with the establishment; twenty oxen and two horses are also necessary for hauling the timber required to streams and to other places. The boards, deals and scantlings sawed at these mills, excepting such as are required for the use of the neighboring settlers, are rafted down the river for shipping. As fresh waters change the colour of the deals from their fresh whiteness to a dark gray and, in the eyes of prejudice, depreciate their value, it becomes an object, but one that can only be attended to occasionally to carry them down in bateaux, scows or on timber rafts."[1]

A study of the Census of Canada returns of forest products of farms for the counties of the watershed

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1. John McGregor, 1833. British America, Vol. II.

FOREST PRODUCTS OF FARMS - CENSUS OF CANADA FIGURES - OXFORD COUNTY

Product	Species	Unit	1870	1880	1890	1900	1910	1920	1930	1940
Tanbark		Cord	586	444	106	79				
Lathwood		"	193	37	84					
Masts & Spars		Number		226	8	20	9			
Staves		Thousands	634	1,7C4	81	1,810	899			
Fence Rails		Number						4,130	1,920	
Fence Posts		"			56,309	32,304	10,542	12,815	14,479	
Poles		"			51	313	195	15	516	
Rwy. Ties		"			3,005	25	50			
Sq. Timber	White Pine	Cu. Ft.	13,264	12,791	29,601	3,022	4,000			
	Red Pine	"	614	1,418	800					
	Ash	"				2,824	800			
	Oak	"	41,950	59,921	5,345	4,368	1,550			
	Tamarack	"	52,525	38,291	19,895					
	Birch/Maple	"	3,545	29,663	8,427	2,624	4,718			
	Elm	"	166,196	78,025	46,522	98,457	25,382			
	Walnut	"	300		300					
	Butternut	"	1,436	1,000	4,850					
	Hickory	"	7,830	5,472	11,000					
	Others	"	94,557	116,168	40,337	6,881	4,000			
Logs, Softwood	Pine	Number	35,788	105,020	55,762	331 M	178 M			
	Hemlock	"				197 M	26 M			
	Hickory					13 M				
	Oak					164 M	51 M			
	Spruce					57 M				
	Elm					2,134 M	1,397 M			
	Others	Number	13,157	164,538	289,767	1,540 M	1,184 M	17,770 M	641 M	
Fuelwood		Cord	142,282	165,169	137,571	128,640	61,311	73,816	49,203	5,542
Other Products		Value $					96	100	731	14,315

M = 1,000 feet board measure

given in the table reveals the various trends and changes in the lumber industry fairly clearly.

From 1870 to 1890 much of the timber was squared and measured in cubic feet. In 1870 other products listed were firewood, staves, lathwood, tanbark, and masts and spars. In 1880 the peak production of nearly all items was reached and squared elm alone in Perth County and squared oak in Middlesex ran to almost 174,000 and 481,800 cubic feet respectively in 1880. In 1890 fence posts and telephone poles were added to the list of products, as were railway ties. In the census years of 1900 and 1910 square timber was still recorded in cubic feet and logs were measured in board feet; staves, lathwood, masts and spars and tanbark disappeared from production.

In 1920 no square timber is shown, logs are only counted, not measured, and not even separated by species. The returns of the latest census covering the year 1940 name only one forest product and the rest are all listed together as others valued at so many dollars. The one product which has persisted throughout the records is firewood which in Middlesex County has dropped from a peak of 267,756 cords in 1880 to 47,230 cords in 1940.

One or two interesting observations with regard to individual species may also be made. Tamarack was listed regularly until 1890, after which it no longer appears due to the depredation of the larch saw-fly which almost wiped it out at this time. The returns show that some black walnut and hickory were cut in all counties each year until 1880. White pine was, of course, the species most sought after, though not much existed in the counties of the watershed, and next to it red pine of which a little was present in all counties. In 1870 and 1880 elm and oak were the main species which were squared, but as these species became scarce more ash, birch, and maple were made into square timber.

FOREST PRODUCTS OF FARMS - CENSUS OF CANADA FIGURES - PERTH COUNTY

Product	Species	Unit	1870	1880	1890	1900	1910	1920	1930	1940
Pulpwood		Cords								10
Tanbark		Cords	2,556	2,533	1,591	12	11			
Lathwood		Cords	184	108	45					
Masts & Spars		Number	30	507						
Staves		Thousands	405	1,921	35	9	74			
Fence Rails		Number						10,223	29,769	
Fence Posts		Number			45,845	4,965	580	5,815	5,149	
Poles		Number					6	5	49	
Railway Ties		Number			646				100	
Square Timber	Ash	Cu. Ft.				20,669	1,800			
	Birch	"				886	1,000			
	Elm	"			103,137	113,528	8,742			
	Maple	"				36,224	39,478			
	Oak	"	8,933	55,243	2,100	1,830				
	Pine	"	16,241	47,687	52,815	2,350				
	Others	"				43,060	8,474			
Logs (Lumber)		Number						17,147	462M	
Logs Softwood	Pine	Cu. Ft.	61,112	154,017	15,423	162M				
	Others	"	35,187	197,527	51,180					
	Spruce	"				5M	3M			
Logs Hardwood	Tamarack	"	7,388	6,530						
	Oak	"				66M	75M			
	Maple and Birch	"	5,806	7,611	2,505					
	Elm	"	103,902	174,632		2,209M	1,647M			
	Black Walnut	"	160	525						
	Butternut	"		131						
	Hickory	"	530	100	45	5M	1M			
	Others	"	170,342	330,998	40,375	611M	284M			
	Hemlock	"				200M	32M			
Fuelwood		Cords	115,030	134,429	95,499	96,568	44,470	56,244	35,952	27,127
Other Products		Value $						772	740	10,590

M = 1,000 feet board measure

5. Shingle-Making

In the history of roofing used on the Thames Watershed it is found that the first covering for human habitation on the river was the Indian elm-bark lashed roof. The first type of roof used by the early settlers was made of "scoops" which were flattened logs, usually cedar, six inches thick with one face scooped out to a depth of one to one and a half inches. These ran from the peak of the roof to the eaves, being placed alternately so that one scoop had the scoop side up and the next one the scoop side down, the edges overlapping the two scoops below.

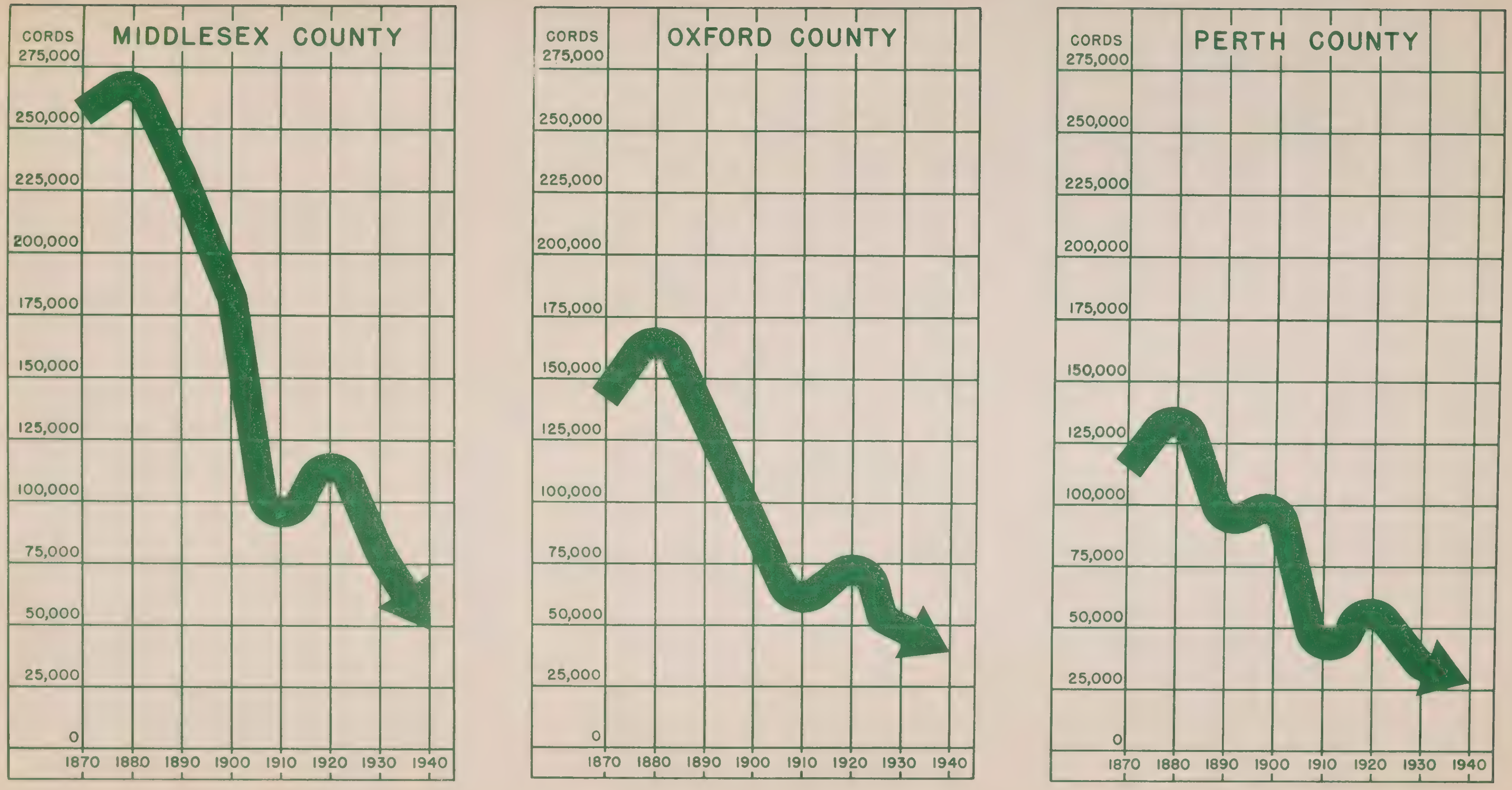
The second type of covering was a rude type of shingle called a "shake". These were made with an axe or frow and were cut from pine or cedar three or more feet in length. Although not shaped they were a great improvement over the early types of covering.

Very early in the history of settlement, however, hand-made shingles were introduced. The shingle-maker would saw the logs into short lengths or bolts and split them with a frow to the right thickness. The shingle was then fastened by one end in a device called a shingle horse and by means of a heavy drawknife the shingle was tapered to an edge. This method was rapid and it has been said that a good shingle-maker would turn out from eighty to a hundred of these hand-made shingles an hour.

Up to the seventies and even later the shingle-maker continued to use drawknife and frow, but gradually in the seventies the generation of craftsmen died out and the shingle mill, where shingles were sawn, became the general source of supply.

6. Fuel and Ties

From the earliest days of settlement on the Thames to 1850, wood was the sole source of fuel supply. All species were used for this purpose including beech and maple -



FUELWOOD PRODUCTION

CENSUS OF CANADA FIGURES

although these were furniture woods as well. With the inception of the railway and steam-driven factories, the forests of the area were ruthlessly cut to feed industry.

In the very early days of the steamship, 1832, the Honourable Adam Fergusson writes: "Wood is furnished upon the St. Lawrence for one dollar, or five shillings per cord while upon the Hudson it now costs three times as much. A man may prepare two cords a day, but it is severe work, and the price, which is one dollar per cord, will do little more than compensate maintenance and labour - and an ordinary steamboat consumes fifty or sixty cords or about 7,000 cubic feet each trip (from Montreal to Quebec)". The price of cordwood in 1825 was quoted at $2 a cord.

With the completion of the Great Western between Toronto and London in 1853, locomotive requirements took large quantities of the best body hardwood, chiefly beech and maple. "Coal at that time was not to be had and the result was that hardwood was gradually becoming of some value. For cordwood the settlers usually realized from $2.50 up to $3.00 per cord, delivered at the various stations along the railway line. Railway facilities also stimulated the lumber industry."[1]

7. Road Materials and Fencing

In the early days the making of corduroy roads furnished another important wood use. The Indian trails had followed the ridges and natural conformation of the country, but when the "T-square" roads had been laid out in government offices they followed the arbitrary lot and concession lines regardless of natural contours. Many of these roads were built through swamps and in these places corduroy construction was used. Many corduroy bridges and culverts were also placed over the river and its tributary streams.

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1. Waterloo County Forests and Primitive Economics, E. W. B. Snider, 6th Annual Report of the Waterloo Historical Society, 1918.

The building of plank roads - a form of highway in which the planks were laid crosswise and side by side - was done in several parts of the Province. Plank roads alternating with gravel stretches connected the main centres in the southern part of the watershed in 1851.[1] The road from London to Woodstock via Ingersoll was one of these and the road to Port Stanely was planked all the way from London.

Much wood was also used for fencing and for this cedar from the swamps was most common. The troublesome pine stump also was used for this purpose in many parts of the Province, although in very early times it seems that it was left in the field. Around 1900 the wire fence came into use generally and thereafter a fence post industry was developed. These were cut as a rule to a standard length of eight feet, while the diameter varied greatly.

8. <u>Woodworking and Planing Mills</u>

The extensive hardwood forests which formerly existed over the greater part of the region were the reason for the large number of wood-using industries which were established, many of which are still doing a big trade although much of their raw material is now imported.

During the early years of settlement in the rural districts and communities, house trim for exterior and interior use was made by the same man who constructed the frame of the house. The custom up to the fifties at least was for the carpenter to board with the family the winter before the new frame house was to be built and work all his timber into shape by hand, both for exterior and interior use.

The early carpenter also made door and window frames and all interior trim of the house by hand and for all these products pine was the usual type of timber chosen. It would seem that doorsteps were one of the very few things

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1. Canada: Past, Present and Future. W. H. Smith, 1851.

for which oak was used in house building, at least up to the sixties.

Generally, as time passed, the building trades became more differentiated and more craftsmen settled on the watershed.

After the appearance of the planing mill in the fifties the end of the hand-made door and window frame was foreshadowed and much of the general carpenter's work was taken over by mill or factory. By the 1860's the planing mill business was well under way.

9. Wooden Implements and Vehicles

(a) Early Tools

From the very early days hickory was preferred for the making of axe-helves or handles, while for beams or ox-yokes beech was used extensively and, for the loop, ironwood would have been selected. Spike handles were made of rock elm, white ash, hickory or ironwood; the beetle-head (a mallet used for pounding hemp and flax) was also made of ash, elm, hickory or ironwood. The hardwoods growing on the watershed were used almost entirely for making handles of implements, whereas pine was preferred for all building operations when it could be obtained.

(b) Vehicles

From early times the making of vehicles progressed as carts, wagons, sleighs and hay and woodracks were built by the farmers. In the building of carts and wagons, whiffletrees, wagon-tongues and binding poles were made of rock elm, white ash, hickory and ironwood, as were also sleigh-runners and hay and woodracks. Usually the wheels or runners of these conveyances were bound with iron, although the use of metal was limited in early days since the supply had to be imported by water.

10. Indirect Products and By-Products

The three indirect products of greatest

importance were potash, maple sugar and tanbark. Maple sugar furnished the staple sugar for the pioneers, cane sugar not having been procurable at that time; lye or potash was used domestically in making soft soap - almost the universal soap; tanbark was utilized by the shoemakers in dressing leather.

(a) Potash

The ashery played an important role in the drama of pioneering life; and besides communal asheries the individual ash house and the ash barrel on a platform for leaching was a characteristic of each farm in the days before the soap factory.

> "Only from the sale of potash (exported to Great Britain and the United States for the dyeing of textiles) was there money for all other requisites. The potash was laboriously produced, men, women and children sharing in the heavy work. No less than 60 large maple trees were required for a barrel of 650 to 700 pounds of potash. The ashes of the burnt wood were leached in wedge-shaped wooden troughs and this liquid was then boiled down and cooled in huge vessels or coolers where the lye solidified. Two coolers would fill a barrel. If the settler marketed this on his own, 'toting it out' to the nearest buyer for ready cash, he might get only $8.50 to $9.00, but if he could wait and accept a down payment from the traders and shippers who teamed and hauled at a season of their own convenience, he might get $10 or $12 with a possible second payment after marketing it at Montreal where a barrel might bring $30, less of course commission, risk and portage costs. The need for this pitifully hard-won money led to clearing of more land than could be cropped and not infrequently to concealing for years the fact that the holding itself might not be profitable or capable of sustaining the settlers from the growth of its poor soil."[1]

(b) Maple Sugar

The table shows the Census figures for maple products in Middlesex, Oxford and Perth Counties. It is interesting to note that up to 1910 production is all recorded as pounds of sugar; from 1910 on both pounds of sugar and gallons of syrup were shown, indicating the change from a pioneer necessity to the modern luxury. For purposes of comparison the sugar figures have been converted to their syrup equivalents and from these shown in the second table it will be seen that production for

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1. A Hundred Year A-Fellin', 1842 - 1942. Gillies Bros. Ltd. 1942.

MAPLE SUGAR PRODUCTION

CENSUS OF CANADA FIGURES

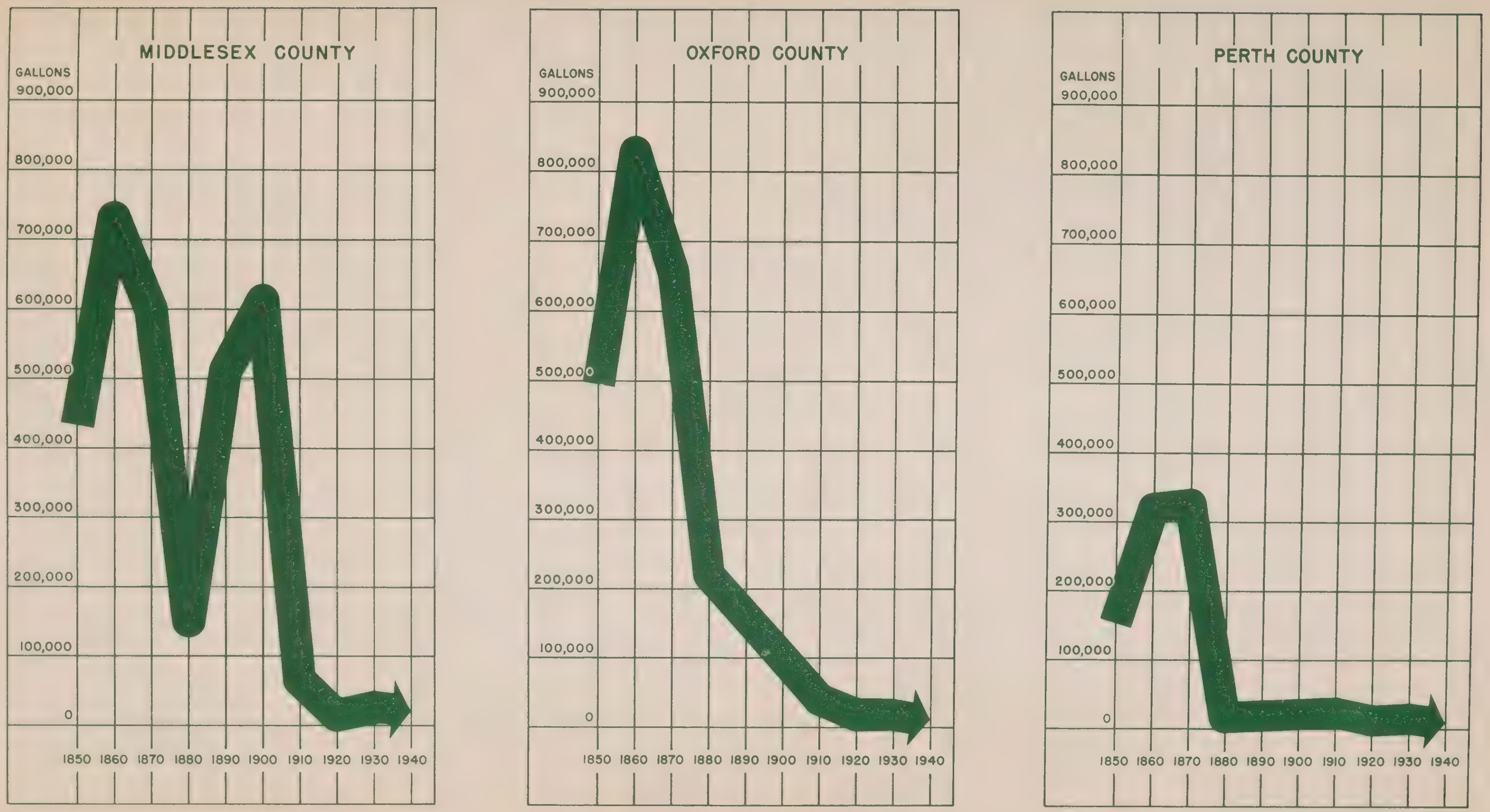
County	1850	1860	1870	1880	1910		1920		1930		1940	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Gals.	Lbs.	Gals.	Lbs.	Gals.	Lbs.	Gals.
Middlesex	279,475	478,627	287,795	99,971	6,001	48,513	1,446	14,052	820	25,721	1,859	15,331
Oxford	320,952	538,373	425,105	142,880	2,580	35,110	50	17,926	215	16,689	194	9,705
Perth	99,125	207,286	210,224	9,037	803	21,269	209	9,503	140	13,627	810	6,343

County	1850	1860	1870	1880	1910	1920	1930	1940
	Gals.	Gals.	Gals.	Gals.	Gals.	Gals.	Gals.	Gals.
Middlesex	430,391	737,086	597,204	153,995	57,775	16,279	26,984	18,194
Oxford	494,266	829,094	654,662	220,035	39,073	18,003	17,020	10,004
Perth	152,653	317,148	323,745	13,917	22,506	9,825	13,843	7,590

Figures for 1890 and 1900 not available.
In the second table, pounds of sugar have been converted to their equivalents in gallons for purposes of comparison.

Middlesex County dropped steadily from the peak of nearly 737,000 gallons in 1860 to 18,194 in 1940, and a similar fall is shown in the other counties.

Wood-using industries of the present time are given in Chapter 10 and there is no reason why, with optimum land use, a good deal of the timber required to support these industries cannot be grown within the watershed in perpetuity, using land which is unsuited to agriculture and land which requires woodland cover for natural water storage and run-off control with the consequent advantages to both urban and rural communities.



MAPLE SYRUP PRODUCTION

CENSUS OF CANADA FIGURES

CHAPTER 3

PRESENT WOODLAND CONDITIONS

The upper Thames Watershed lies almost wholly within the Huron-Ontario Section of the Great Lakes-St. Lawrence Forest Region[1]. This section is characterized by a forest in which maple and beech are the dominant species. With them are basswood, white elm, white ash, some yellow birch and red maple and red, white and bur oak. Small groups of hemlock and white pine occur within the association as well as a scattered distribution of large-toothed aspen, bitternut hickory, butternut, ironwood and black cherry; blue beech, slippery and rock elm and black ash are found locally on specialized sites such as bottomlands and swamps. White pine occurs mostly on the lighter soils of the moraines. Trembling aspen occurs on the poorly drained soils where the stands have been cut and burned in the past.

The almost level till plain which includes Logan, Ellice and parts of North and South Easthope and Downie Townships was originally covered with a hardwood swamp forest, composed chiefly of silver maple and white elm. Most of this has been cleared and drained for agricultural purposes, but the remaining woodlots are largely of this type. The large swamps such as the Ellice and Gads Hill Swamps supported a mixed forest of conifers and hardwoods but repeated fires have reduced these to aspen and scrub willow areas.

South and west of these townships the till plain is much more broken up by moraines, spillways and drumlinoid features which created better natural drainage and the forest was of the beech - sugar maple type which is also reflected by the remaining woodlots; though even here the poorly drained areas such as the Golspie and

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1. Forest Classification for Canada. W.E.D. Halliday, 1937.

Dorchester Swamps were characterized by hardwood types such as silver maple - elm.

In the large moraine area south of the Thames River the topography is rougher, the natural drainage more pronounced, and it is here that most of the white pine of the watershed grew, particularly on the lighter soils. The kame moraine running south-west from near Harrington West supported fair stands of white pine on its lighter soils, but these have largely been replaced by beech - sugar maple woods. Some cedar occurred in the spillways, particularly on muck, and it is here that the remaining stands are still found.

The extreme south-west corner of the Thames Watershed south-west of the city of London lies in the Deciduous Forest Region. The Deciduous Forest reaches its northern limit here and is composed almost entirely of broad-leaved trees including black and chestnut oak, shagbark and pignut hickory and walnut. White pine occurs on the drier sites and hemlock on the cool well-drained slopes.

1. Survey Methods

Each member of the Forestry party was provided with aerial photographs which were on a scale of 1,000 feet to the inch and each photograph covered an area of approximately 1,000 acres, usually a block lying between two adjacent concession roads and two adjacent side roads. Mapping was done in the field directly on the photographs.

Every area of woodland, brushland, marsh, swamp and rough land down to one acre in area was examined and notes made describing it. In the case of woodlots and plantations, detailed notes were made of their condition. Overgrazed woodlots and woodlots with very scattered trees which could be restored were classified as woodland. In short, where doubt existed as to whether an area should be classified as woodland or not, woodland was given the benefit of the doubt.

FOREST COVER TYPES

Township	No. of Woodlots	Total Acres	4	4A	6	8	9	10	11	12	13	14	14A	15	24	25	26	45	47	49	50	51	52	57	58	59	60	60A	61	88
Biddulph	77	382	3								4	48					11							89		65	84	75		3
Blandford	202	1,260	297				1	4	7	11	7	98	3	3	70		105							233		37	358	24		2
Blanshard	167	1,469									209	317										9		447		35	185	266		1
Caradoc	80	608	53				4								1		5			312	35	4		37		26	91	25		15
Delaware	144	833	26	28	11	24	1		26	6	18	122			50	6	25			124	48	82		50	4	53	25	61	32	11
Dereham	276	2,045	179			5				12	16	195		16	48	6	66	9		6		4		368	17	165	556	355		22
Dorchester S.	18	179	19				5								15		74							45	9	5		7		
Dorchester N.	562	4,647	550				55	2	150	6	22	330	2	9	450	60	778			6	8		2	720	55	167	817	414		44
Downie	311	3,267	68							77	123	123			43		120	27			3			735	13	260	1,261	398		16
Easthope N.	219	2,806	1,039						16		32	47	1		163	18	259							678		35	309	196		13
Easthope S.	217	1,261	51						2		51	41			14									457	37	110	324	170		4
Ellice	292	3,676	1,997						6	163	57	127			11									250		32	461	525		47
Elma	11	42	10														6							7		6		13		
Fullarton	362	3,064	46								144	736					113	3						631	43	219	606	519		4
Grey	4	17																								11	6			
Hibbert	79	753	14								6	177	4		10		7							248	6	38	116	127		
Lobo	147	857	81	54	1	20			14		30	71	7		60	6	74			144	49	1		113		28	14	57	6	27
Logan	231	1,728	284							155	47	140			12		2							345		84	534	123		2
London	744	5,607	124			4			4	165	98	584	16	18	142	17	90	20	7	135	111	16		1,509	55	676	858	806		152
McKillop	2	16	11																							5				
Mornington	11	84	53							12																	19			
Nissouri E.	495	3,617	103					7	6	47	50	411	12	56	205	43	76	22						1,116	105	262	530	547		19
Nissouri W.	365	2,541	107								75	324	4		7		27							870	10	337	375	389		16
Norwich N.	15	113										5					6							26		18	52	6		
Oxford E.	118	1,177	11						62		26	79			113		116					11		79	4	53	444	158		1
Oxford N.	243	1,129	61								54	163	8	2	42		39		1				1	230	55	76	143	188		66
Oxford W.	274	1,971	90			5	2		34	11	31	352	17	18	409	5	87					21	20	237	109	73	233	183		34
Usborne	57	406									20	196												10	5	79	44	50		2
Westminster	440	2,815	20		2		1	2		5	102	283	22		15	1	42	1	6	251	32	83		636	51	471	585	139		65
Zorra E.	499	3,083	103							28	97	248			242		42							792	119	56	919	386		51
Zorra W.	617	5,572	362				8			19	7	417	27		413	35	9					4		1,539	115	214	1,401	944		58
Total Acres	7,279	57,025	5,762	82	14	58	77	15	327	717	1,326	5,634	123	122	2,535	197	2,179	82	14	978	286	235	23	12,497	812	3,696	11,350	7,151	38	675
Per Cent		100.0	10.1	0.1	0.0	0.1	0.1	0.0	0.6	1.3	2.3	9.8	0.2	0.2	4.4	0.3	3.8	0.1	0.0	1.7	0.5	0.4	0.0	22.3	1.4	6.5	20.0	12.6	0.0	1.2

All woodlots were grouped according to the following classification:

Diameter Breast High	Hardwood	Mixed Wood	Coniferous
Virgin	H-1	M-1	C-1
Over 18 inches	H-2	M-2	C-2
10 - 18 inches	H-3	M-3	C-3
4 - 10 inches	H-4	M-4	C-4
Under 4 inches	H-5	M-5	C-5

In this classification the term "hardwood" is used to denote all broad-leaved trees irrespective of whether the wood is physically hard or not. A hardwood type is one in which 80 per cent or more of the stand is composed of hardwood trees, a coniferous type is one in which 80 per cent of the stand is composed of coniferous trees and a mixed stand embraces all others.

Stands were also recorded according to forest cover types[1]. (Refer to the table, the description of forest cover types and the forestry map folded at the end of this report.)

The forestry map is on the scale of one mile to the inch and covers the whole of the Thames Watershed above the confluence of Dingman Creek. It shows all existing woodland, existing Authority and County forests, scrub land, and land recommended for acquisition by the Authority.

A forest cover type may be either temporary or permanent; for example, the present stand may be aspen which has seeded in the area following fire. Aspen seed is light like dandelion seed and is carried easily by the wind, thus it quickly covers large areas; also it is not exacting in its soil requirements and may be the only species which will grow under the soil conditions existing at the time.

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1. Forest Cover Types of the Eastern United States. Report of the Committee on Forest Types, Society of American Foresters. 1940.

The fact of its growing and dropping its leaves on the ground gradually improves the condition of the soil so that more exacting species can grow. In addition its light shade frequently provides the correct light conditions for better species to get a start. As it is a short-lived tree, it will die early and the other species will dominate the area. This succession may be carried through two or more stages until the species best suited to the area or best able to maintain itself on the area takes over; this is called the forest type or climax type, as distinguished from the forest cover type which is the type occupying the ground at the present time. The most common forest type on the Upper Thames Watershed is sugar maple - beech.

No classification of forest cover types has been made in Canada for Southern Ontario, so the system used is a slightly modified form of that drawn up by the Society of American Foresters, which covers the whole of the eastern United States; consequently there are many types in their classification which do not enter Canada and this accounts for the gaps in the numerical listing of types occurring in the Thames Watershed. The forest cover types of the Thames Watershed may be listed as follows:

Number	Name
4	Aspen
4A	Poplar - oak
5	Pin cherry
6	Paper birch
8	White pine - red oak - white ash
9	White pine
10	White pine - hemlock
11	Hemlock
12	Sugar maple - beech - yellow birch
13	Sugar maple - basswood
14	Sugar maple
14A	Black cherry
15	Yellow birch
24	White cedar
25	Tamarack
26	Black ash - white elm - red maple
45	Bur oak
47	Black locust
49	White oak - black oak - red oak
50	White oak
51	Red oak - basswood - white ash
52	Red oak

Number	Name
57	Beech - sugar maple
58	Beech
59	Ash - hickory
60	Silver maple - white elm
60A	White elm
61	Cottonwood
88	Willow

Type 4: Aspen

Aspen is a pioneer type coming in after fire or overgrazing. Though it avoids the wettest swamps it does grow on soils that are wet throughout a good part of the year, as well as on dry soils. Its associates may be white elm, paper birch, red cherry and balsam poplar, with occasionally large-toothed aspen and green ash. It forms over 10 per cent of the woodland of the watershed, with fairly extensive stands occurring on the peat and muck areas such as the Ellice Swamp.

Type 4A: Poplar - Oak

This is a residual type on the light soils of the moraines following logging and fire. The oak usually consists of trees of white, red and sometimes bur oak which have survived due to their resistance to fire, and poplar, either trembling or large-toothed, which has seeded in later. The site is usually a white pine site and scattered trees of this species frequently occur with patches of good white pine reproduction appearing through the area. It includes only 82 acres of woodland in Lobo and Delaware Townships.

Type 6: Paper Birch

This is a pioneer type of clear-cut and pastured areas succeeded by other northern hardwood types or white pine. Its associates include small proportions of aspen, white pine, hemlock, red maple, red oak and basswood. Frequently an understory of conifers or tolerant hardwoods develops. It occurs on sandy soils in Delaware and Westminster Townships, but is rare on the Thames watershed, only 14 acres having been mapped.

Type 8: White Pine - Red Oak - White Ash

This type occurs with red maple as the most common associates though others which may be present are basswood, yellow birch, large-toothed aspen, sugar maple, beech, paper birch, black cherry and hemlock. Only 58 acres were found on the watershed.

Type 9: White Pine

White pine typically occurs on fresh, sandy loam upland but also on clay, in swampy areas and on loamy sand. On sandy soils on the moraines it tends to be permanent but on heavier soils it is usually succeeded by the following types, sugar maple - beech - red oak - basswood - white ash, white pine - red oak - white ash, white pine - hemlock, sugar maple - basswood, or white oak.

Its associates on light soils are aspen, red maple, pin cherry and white oak; on heavier soils yellow birch, black cherry, white ash, red oak, sugar maple, basswood and hemlock. It was never very abundant on the watershed but now occupies only 77 acres of the wooded area, mostly in North Dorchester Township.

Type 10: White Pine - Hemlock

Associated with this type are many species but none is particularly characteristic. The principal ones are beech, sugar maple, basswood, red maple, yellow birch, black cherry, white ash, paper birch and red oak. It occurs on a range of sites from sand plains to heavy upland soils, but favours cool locations such as the slopes of ravines. It constitutes only 15 acres of the woodland.

Type 11: Hemlock

This type occurs mostly in widely scattered bodies in cool locations, moist ravines and north slopes, frequently in the sugar maple - beech type. Its associates are beech, sugar maple, yellow birch, basswood, red maple, black cherry, white ash, white pine, paper birch and red oak. It makes up a little over 1 per cent of the remaining woodland

Mixed forests of broadleaved trees and conifers occurred sparingly on the lighter soils but due to the scarcity of softwood timber have largely disappeared.

The few stands of white cedar have been severely overcut and badly damaged by cattle. Those remaining should be fenced and managed as a source of posts and poles.

of the Thames Valley but was never abundant because of its preference for cool ravines, of which not many exist. It occurs mostly in North Dorchester, Delaware and Oxford Townships.

Type 13: Sugar Maple - Basswood

This is a fairly important type occurring on loamy, upland soils. Its associates are white elm, green ash, yellow birch, white pine and red oak with ironwood and blue beech as subordinates. It forms almost 2½ per cent of the woodland of the watershed and the percentage is probably being continually reduced as basswood is a more sought-after species than sugar maple.

Type 14: Sugar Maple

This type undoubtedly originally covered a considerable part of the watershed but since it occupied fertile, well-drained soil with good moisture much of it has been cleared for agriculture. A small proportion of other species such as yellow birch, white ash, red and white oak may be present. Today it covers almost 10 per cent of the wooded area. Its area may have been increased in recent years by the removal of beech from Type 57.

Type 14A: Black Cherry

This type is not common but second growth stands occur usually on fertile, moist, well-drained soils, frequently those formerly occupied by hemlock. Its associates may be sugar maple, red oak, red maple, white ash, basswood, butternut, white elm and hemlock. Only 123 acres were found on the Thames Watershed, mostly in the south part.

Type 15: Yellow Birch

This type is really an intrusion from further north and occurs only in the cool swamps of the glacial meltwater channels; its associates are white cedar, hemlock and red maple. It is of minor importance and comprises only 122 acres.

Type 24: White Cedar

The associates of this type are tamarack, yellow birch, paper birch, black ash, red maple, white pine and hemlock. It occurs on sites of slow drainage which are not strongly acid, including the muck soils of the watershed, and is also present on poor pasture land and bottomland. It forms over 4 per cent of the woodland and is the chief source of fence posts and poles.

Type 25: Tamarack

Tamarack occurs in muck swamps with little or no drainage, associated with white cedar and less commonly with red maple, black ash and aspen. The trees are small and have grown since the near-extinction of the species in the early part of the century. No extensive areas existed in the past and today it occurs on 197 acres, mostly in Dorchester North, Nissouri East and Zorra West Townships.

Type 26: Black Ash - White Elm - Red Maple

This type occupies moist to wet soils in swamps, gullies and small depressions. Its associates are balsam poplar, yellow birch, with sometimes white pine, tamarack, white cedar, basswood and bur oak. It comprises almost 4 per cent of the woodland.

Type 45: Bur Oak

This is a very uncommon type in Ontario, the associates of which are red oak, white oak or black oak, and occurs on loamy slopes with south or south-west exposure. Only 82 acres are present on the Thames Watershed.

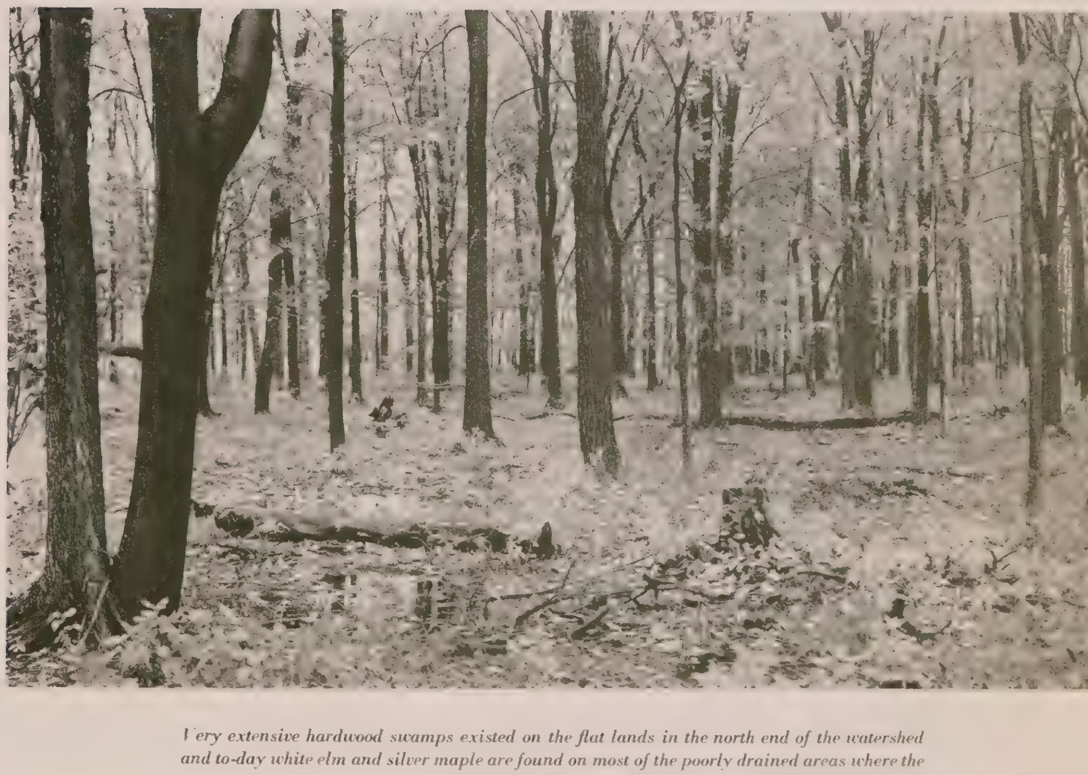
Type 47: Black Locust

This species does not occur naturally in Ontario but has been planted fairly extensively, largely for erosion control purposes, and has escaped from cultivation. It grows best on dry sites, especially on limy soils. Fourteen acres were mapped on the Thames drainage area.

Type 49: White Oak - Black Oak - Red Oak

This type belongs to the Deciduous Forest Region and occurs on light soils in the south-west corner of

Most of the watershed of the Upper Thames was originally covered with a beech-sugar maple forest and this is still the most common type in farm woodlots.



Very extensive hardwood swamps existed on the flat lands in the north end of the watershed and to-day white elm and silver maple are found on most of the poorly drained areas where the woods have survived.

the watershed. Being at the limit of the region, black oak may be absent. Associates are bur oak, shagbark or bitternut hickory, white or green ash, sugar maple and, occasionally a few black cherry, butternut or large-toothed aspen. Almost 1,000 acres still exist on the Thames Watershed.

Type 50: White Oak

The chief associates in this type are black oak and shagbark hickory. It also belongs to the Deciduous Forest Region and occurs on light soils, mostly in the south-west part of the watershed. There are 286 acres in all.

Type 51: Red Oak - Basswood - White Ash

Associated with the type species are red maple, yellow birch, aspen, sugar maple, paper birch and beech on less well-drained soils. This is a moderately important type, there being 235 acres in the watershed.

Type 52: Red Oak

Red oak may be pure or associated with white oak on ridges in park-like stands. The trees are short-trunked and flat-topped. About 22 acres occur in the south part of the watershed.

Type 57: Beech - Sugar Maple

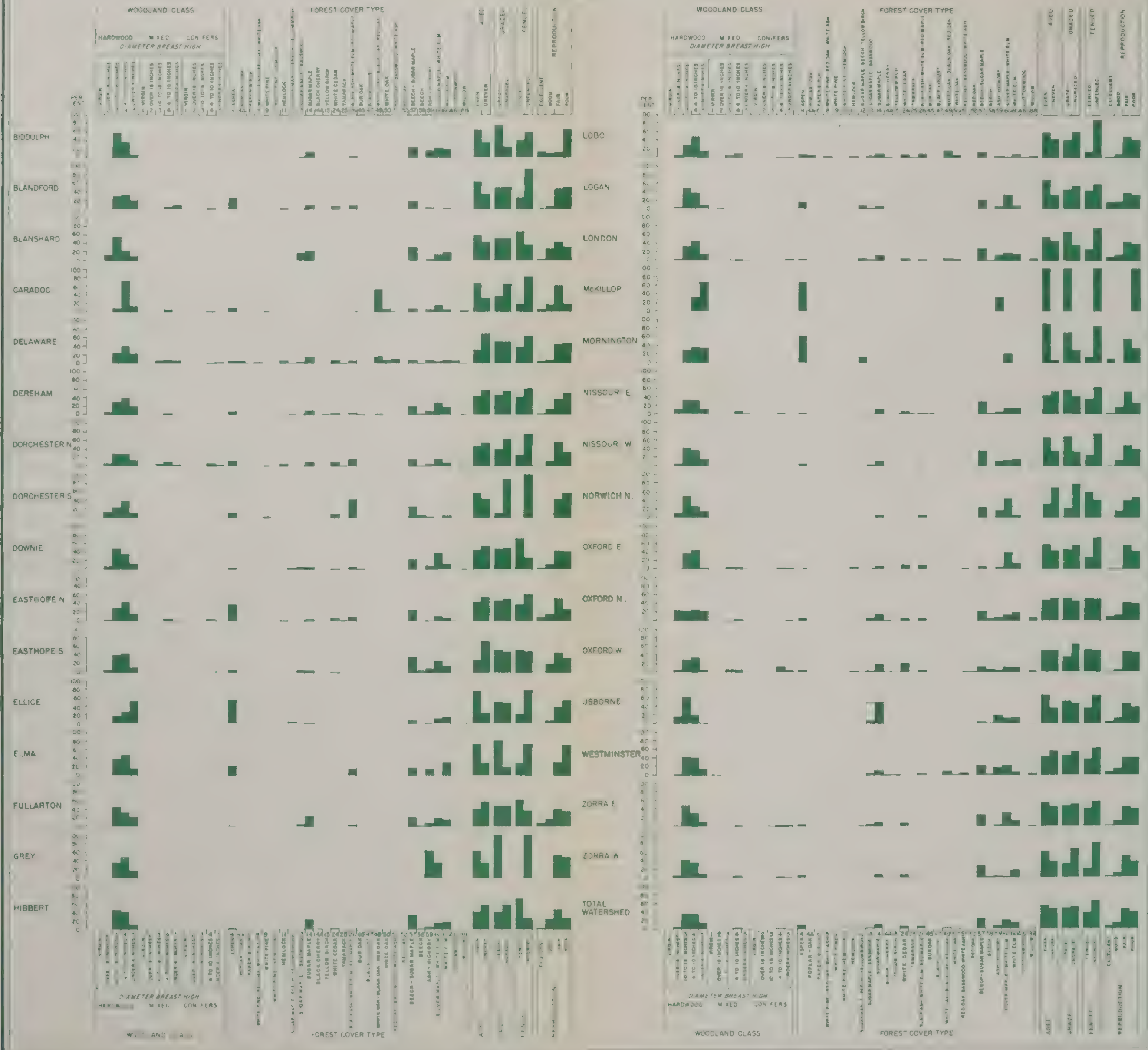
This is regarded as the typical association of the climax with red maple, white oak, red oak, hemlock, white elm, red elm, basswood, shagbark hickory and black cherry. This type was undboutedly very extensive in the Thames Watershed but, because it occupied the best land, its area has been tremendously depleted. However, it still comprises over 22 per cent of the remaining woodland and is very generally distributed.

Type 58: Beech

This type also belongs to the Deciduous Forest Region and is, theoretically, the ultimate dominant of the climax, but it is almost invariably associated with sugar maple. Its other associates are red maple, red oak, white ash, white elm, red elm and bitternut hickory. Over 800 acres were

WOODLAND CONDITIONS BY TOWNSHIPS

1950



mapped in the Thames drainage area. A few areas were encountered where the type had originally been 57 and the sugar maple taken out for logs, leaving the inferior beech.

Type 59: Ash - Hickory

This type is not listed in the American classification but has been introduced because of its frequent occurrence in Southern Ontario. It is usually a residual type following cutting and grazing, often of Type 60: silver maple - white elm, though it may occur on any poorly drained, cut-over area. It is usually composed of a mixture of white, green or red ash and shagbark and bitternut hickory with bur oak, cottonwood, blue beech and ironwood as associates. It constitutes over 6 per cent of the woodland.

Type 60: Silver Maple - White Elm

This is a type of meltwater channels and poorly drained soils unsuitable for general farming unless completely and adequately underdrained; for this reason it and the similar white elm Type 60A have survived better than forest cover types on better drained land. Associated species are red maple, slippery elm, cottonwood, white, red and green ash, bur oak and bitternut hickory. This type represents 20 per cent of the woodland of the watershed and is the second most abundant type in the Thames drainage area.

Type 60A: White Elm

Type 60A is very similar to the silver maple - white elm Type 60, but is found on drier sites as well as swamps and swales and its associated species are the same. It is not listed in the American classification but has been introduced here because of its frequent occurrence in Southern Ontario. It comprises over 12½ per cent of the woodland, so that these two types together make up over 32 per cent of the total woods in the watershed.

Type 61: Cottonwood

This type is not common. The species is usually mixed in the two preceding types, but small, almost

WOODLOT CLASSES

TOWNSHIP	NO. OF WOODLOTS	AREA	H1	H2	H3	H4	H5	M2	M3	M4	M5	C1	C3	C4	C5
Biddulph	77	382		2	220	133	27								
Blandford	202	1,260		6	377	405	261		15	71	105		5	12	3
Blanshard	167	1,469		202	812	316	139								
Caradoc	80	608			54	443	80			26				5	
Deleware	144	833		3	193	338	184	2	30	33	29			7	14
Dereham	276	2,045		150	613	814	378	4	30	48				6	2
Dorchester S.	18	179		22	40	71	19		5	12				10	
Dorchester N.	562	4,647		230	1,342	1,305	643		180	483	115		8	204	137
Downie	311	3,267		192	1,537	1,129	369			26				14	
Easthope N.	219	2,806		103	819	1,198	447		10	122	18		10	62	17
Easthope S.	217	1,261		61	508	547	132			4					9
Ellice	292	3,676		9	694	1,038	1,921			12					2
Elma	11	42			16	20	6								
Fullarton	362	3,064	1	44	1,394	962	655		8						
Grey	4	17			6	8	3								
Hibbert	79	753			336	319	88							1	9
Loba	147	857		39	254	327	124		28	64				11	10
Logan	231	1,728		52	837	662	157	15						4	1
London	744	5,607		141	1,758	2,635	836		53	33	5		1	56	89
McKillop	2	16				5	11								
Mornington	11	84			25	30	29								
Nissouri E.	495	3,617		443	1,228	1,154	438		9	232	29			69	15
Nissouri W.	365	2,541		121	1,094	931	377		7	4				7	
Norwich N.	15	113		12	57	29	15								
Oxford E.	118	1,177		6	443	511	42		62	47	6			39	21
Oxford N.	243	1,129		270	270	282	253		11	24	8			2	9
Oxford W.	274	1,971		107	583	675	95	2	98	83	29			250	49
Usborne	57	406		70	248	81	7								
Westminster	440	2,815		33	1,183	1,133	445			4		1	1	12	3
Zorra E.	499	3,083		47	1,510	947	342		7	52	10		25	74	69
Zorra W.	617	5,572		227	2,402	1,902	510		33	239	51	1	24	146	38
TOTAL	7,279	57,025	1	2,592	20,853	20,350	9,033	23	586	1,619	405		74	991	497
PER CENT				4.6	36.6	35.7	15.9		1.0	2.8	0.7		0.1	1.7	0.9

H -- HARDWOOD -- 80% or more of the main stand composed of hardwoods.

C -- CONIFEROUS -- 80% or more of the main stand composed of conifers.

M -- MIXED -- All other stands.

	Hardwood	Mixed Wood	Coniferous
Virgin	H-1	M-1	C-1
Moderately Culled	H-2	M-2	C-2
Severely Culled	H-3	M-3	C-3
Second Growth	H-4	M-4	C-4
Young Growth	H-5	M-5	C-5

pure stands do occur which will give way to the other types as the succession develops. Thirty-eight acres were mapped.

Type 88: Willow

Several species are included in this type but the commonest is black willow. It occurs on wet sites, often on the margins of kettles, and includes 675 acres on the Thames Watershed.

The large map shows the distribution of all types throughout the watershed and from it the following observations may be made:

(a) Elm swamp types which covered extensive areas have survived pretty well throughout the watershed on level land and in the glacial meltwater channels.

(b) Cedar and tamarack swamps which were scattered along the valleys of streams have been severely overcut and pastured, but fairly extensive areas still exist.

(c) Sugar maple types are still the most abundant and are found generally throughout the watershed.

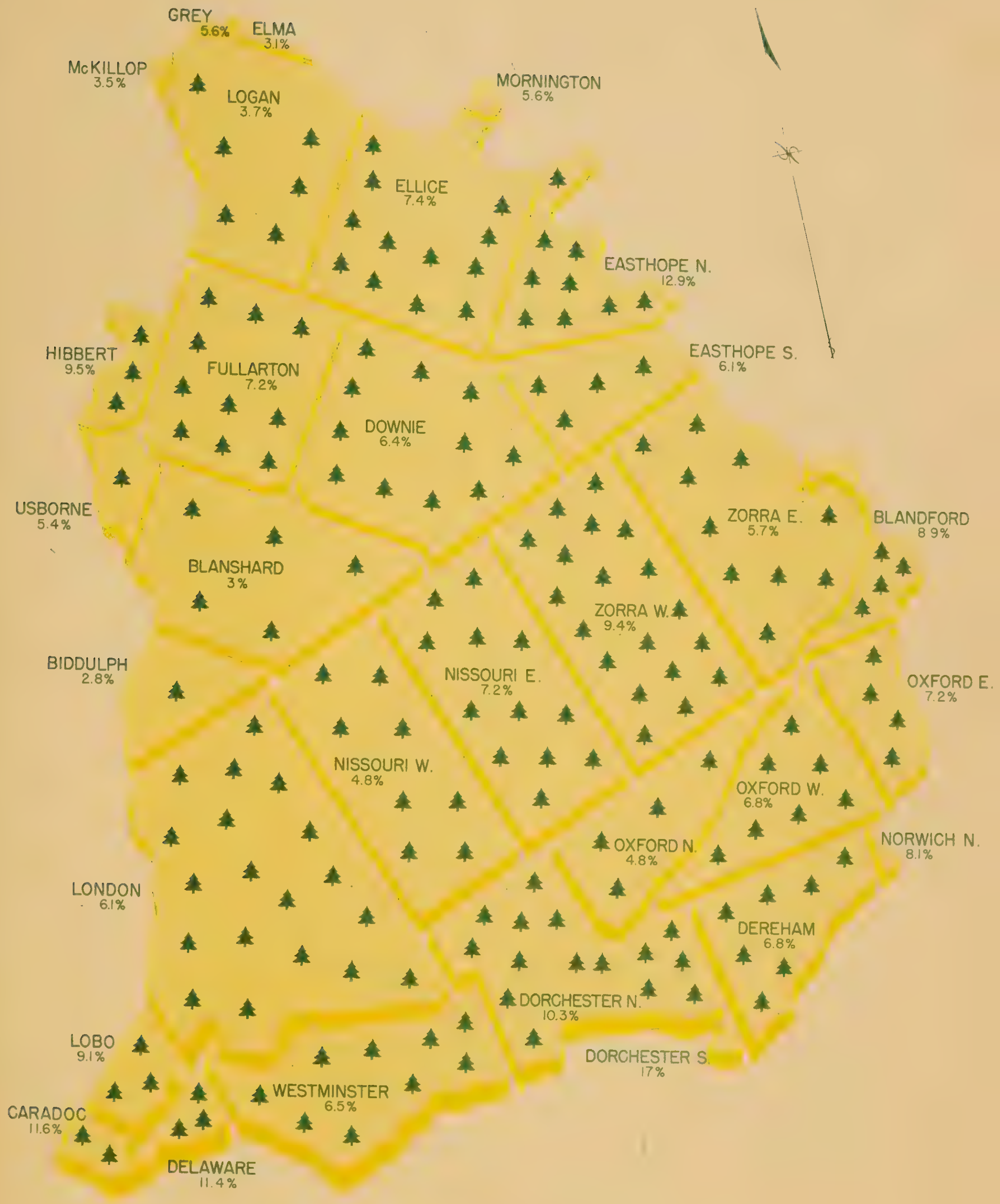
(d) The chief pioneer type following cutting and pasturing is aspen Type 4, which covers light soils on the moraines and muck and peat areas which have been frequently burned over.

(d) The forest types of the Deciduous Forest Region may still be seen in the south-west portion of the watershed.

3. Present Conditions

The results of the forest surveys are summarized in the accompanying table.

Woodland within the watershed comprises 57,025 acres, which is 6.7 per cent of the total area of 847,949 acres. The total number of woodlots examined was 7,279 which includes many areas which are considered by their owners as constituting a single woodlot but which, because of the difference in types and age classes of certain sections, had to be considered in



EXISTING WOODLAND

the field as separate units. Conversely, where property boundaries were not marked, woodland extending across two or more properties was sometimes considered as a unit because the type and age class remained constant throughout.

The conifers occurring in the watershed are white pine, hemlock, white cedar, tamarack and black spruce. Red pine occurred in the original forest but no trees were found in the natural state at the time the survey was made. White pine is fairly generally scattered throughout the moraine areas, especially in the south-east. Hemlock is found mixed with hardwoods and white cedar and tamarack are present in the small swamps. Black spruce is very rare, but was found in one small muskeg, an island of Boreal vegetation, near the London Sanitarium. Conversely there is an outlier of the Deciduous Forest near Lakeside where chestnut grew in considerable abundance before its decimation by the Chinese Chestnut Blight. There is no doubt that conifers formed a larger part of the woodland than they do today, but their numbers have been diminished because of the desirability of the lumber they furnish, and recurrent fires have destroyed them while more fire-resistant species such as oak have survived. The situation at the present time is that of the 57,025 acres of woodland, 93 per cent is classified as pure hardwoods, 4 per cent as mixed woods and 3 per cent as pure conifers. In the 93 per cent classified as hardwoods 5 per cent is over 18 inches in diameter at breast height, 36 per cent is 10 to 18 inches, 35 per cent is 4 to 10 inches and 16 per cent is young growth under 4 inches in diameter at breast height.

In the mixed wood classes, comprising 4 per cent of the woodland, 1 per cent is 10 inches to 18 inches in diameter at breast height, 3 per cent is 4 inches to 10 inches, while less than 1 per cent is young growth under 4 inches. In the coniferous woods 2 per cent is second growth, 4 to 10 inches at breast height, and less than 1 per cent is young growth under 4 inches.

White elm and silver maple occur on poorly drained soil which is frequently heavy clay. Cattle not only destroy the young growth and forest floor but puddle and compact the soil.

Before regeneration can be obtained here, it will be necessary to cultivate the soil well in May before the trees seed in June. The trees have become "stag-headed" from the compaction of the soil.

For the whole area the percentage of uneven-aged stands is somewhat more than the even-aged, the figures being 53 per cent of the former and 47 per cent of the latter.

Grazing in farm woodlots is still fairly general, the percentage of grazed woodland being 50 per cent for the whole watershed. The percentage of grazed woodlots is low as compared with other watersheds. Grazing, as is well known, is detrimental to the proper development of any woodland area. The number of cattle and the size of the woodlot have a direct relationship to the damage which is done. For example, a large woodlot is not as seriously affected by a few head of cattle as a small one, but on most farms the woodlot is small and is seriously damaged by large herds. Grazing in a woodlot destroys young growth, open areas appear and become covered with grass, which means that the maintenance of the forest floor, which is so important to the health of the stand, is interfered with and there is less likelihood of a renewing of the stand by reseeding from old trees. These in turn become stag-headed and are easily preyed upon by fungus and disease.

Fire is a factor menacing woodlands in the swamp areas. It is not necessary to burn a tree to kill it: merely raising the temperature of the growing layer inside the bark to 150 degrees Fahrenheit will do the job, and this is frequently what happens.

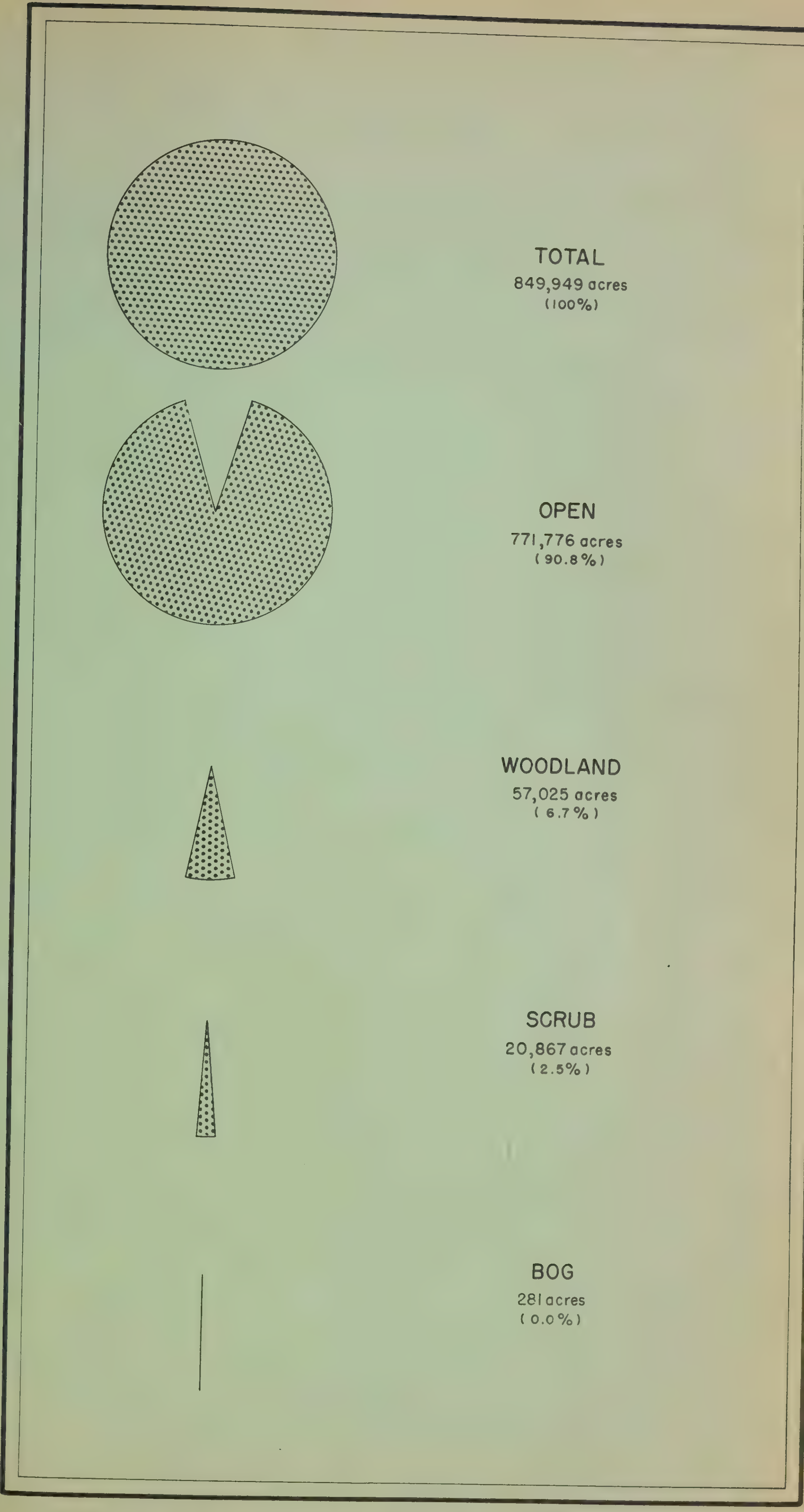
Due to the custom of grazing in the woodlots some stands have become open and require some planting. Of the areas examined 38 per cent are devoid of natural regeneration and 57 per cent require some planting to bring them back to fully stocked stands. Cutting in woodlots and clean-cutting of whole areas has been carried on persistently in the past, but since all the counties of the watershed now have diameter limits this practice has now ceased.

To sum up, 95 per cent of the woods are second growth with a mixture of large trees in many areas, and of

WOODLOT CONDITIONS

TOWNSHIP	NO. OF WOODLOTS	AREA	AGED		GRAZED		FENCED		REPRODUCTION			
			EVEN	UNEVEN	YES	NO	YES	NO	A	B	C	D
Biddulph	77	382	244	138	287	95	156	226	51	39	44	248
Blandford	202	1,260	816	444	625	635	87	1,173	7	87	513	653
Blanshard	167	1,469	840	629	734	735	959	510	34	369	623	443
Caradoc	80	608	406	202	210	398	108	500	36	97	360	115
Deleware	144	833	265	568	421	412	313	520	25	64	361	383
Dereham	276	2,045	866	1,179	944	1,101	842	1,203	57	249	722	1,018
Dorchester S.	18	179	101	78	19	160		179			78	101
Dorchester N.	562	4,647	2,164	2,483	1,794	2,853	1,164	3,483	63	527	2,564	1,493
Downie	311	3,267	1,498	1,769	1,629	1,638	2,355	912	112	363	1,416	1,376
Easthope N.	219	2,806	1,278	1,528	1,378	1,428	1,091	1,715	238	405	1,441	722
Easthope S.	217	1,261	352	909	658	603	657	604	11	255	586	409
Ellice	292	3,676	2,854	822	1,881	1,795	798	2,878	27	222	1,460	1,967
Elma	11	42	30	12	34	8	12	30			13	29
Fullarton	362	3,064	1,278	1,786	1,523	1,541	1,886	1,178	215	556	1,237	1,056
Grey	4	17	11	6	17			17			9	8
Hibbert	79	753	317	436	313	440	549	204	24	183	339	207
Lobo	147	857	492	365	345	512	102	755	25	67	415	350
Logan	231	1,728	1,175	553	803	925	732	996	260	273	648	547
London	744	5,607	3,062	2,545	3,662	1,945	1,415	4,192	418	676	2,399	2,114
McKillop	2	16	16		16			16				16
Mornington	11	84	78	6	59	25	12	72	9		46	29
Nissouri E.	495	3,617	1,648	1,969	2,085	1,532	1,319	2,298	56	634	1,942	985
Nissouri W.	365	2,541	1,657	884	1,728	813	621	1,920	28	306	1,240	967
Norwich N.	15	113	35	78	24	89	67	46		16	45	52
Oxford E.	118	1,177	663	514	536	641	316	861	6	14	673	484
Oxford N.	243	1,129	539	590	602	527	569	560	98	123	465	443
Oxford W.	274	1,971	991	980	673	1,298	1,020	951	28	99	939	905
Usborne	57	406	268	138	214	192	139	267	18	49	185	154
Westminster	440	2,815	1,216	1,599	1,292	1,523	1,058	1,757	162	397	1,129	1,127
Zorra E.	499	3,083	1,667	1,416	1,493	1,590	1,312	1,771	59	378	1,395	1,251
Zorra W.	617	5,572	3,434	2,138	1,807	3,765	1,091	4,481	84	587	2,803	2,098
TOTAL	7,279	57,025	30,261	26,764	27,806	29,219	20,750	36,275	2,151	7,035	26,090	21,750
PER CENT			53.1	46.9	48.7	51.3	36.4	63.6	3.8	12.3	45.8	38.1

these 16 per cent are young growth, the former ranging from 30 to 50 feet in height. The woodlots containing the largest trees are composed of old hardwoods, elm and soft maple in the swamp areas and sugar maple, beech and bass-wood on dry sites.



LAND CLASSIFICATION — TOTAL WATERSHED

CHAPTER 4

CONSERVATION MEASURES IN PROGRESS

When one speaks of plantable land, the first thought of most people is of light, sand land, usually of the "blow sand" type which is the easiest and most economically feasible land to reforest. Most of the reforestation in Ontario to date has been on this type of soil, little of which exists in the Upper Thames Watershed. The absence of sand land and the lack of knowledge concerning the proper methods of planting hardwoods account for the very small amount of reforestation which has been done within the watershed.

Since there are few sand lands in the area, wind erosion is not a problem; similarly, because of the generally level topography, spectacular gully erosion does not exist, although sheet erosion and some gullying occur on the steeper slopes.

For forestry purposes the Department of Lands and Forests has divided Southern Ontario into Forest Districts which are subdivided into zones. Each zone has its Zone Forester and assistants, whose duty it is to give advice and assistance to private individuals and municipalities on the management of their woodlands and the establishment of plantations. The office covering the zone in which Middlesex lies is located in Chatham and the office for Oxford and Perth Counties is in Stratford.

The nearest forest tree nursery to the Upper Thames Watershed is that at St. Williams in Norfolk County, which was established in 1908 and has served as the largest production and distribution centre for trees ever since. Today, 43 years later, the Norfolk Provincial Forest Station of 3,800 acres presents a magnificent young forest of pines and other species. This station also maintains a small sawmill, in which thinnings from improvement cuttings are being manufactured into materials for local use. Thousands of

visitors go to this beauty spot and a small park is provided for their accommodation. Many officials of municipal and other organizations from all parts of the Province have visited this station and returned convinced that all the waste areas of the Province should be reforested and so made useful and beautiful.

1. Private Planting

Reforestation, combined with the protection of natural woodlots, is essential if farmers are to have sufficient woodland to supply the local community with fuel-wood, fence posts and poles, and to have a few saw-logs for sale which will provide a cash crop at times when the prices of other farm products are depressed. Reforestation of certain areas will not only mean that the land will be producing a crop where little or nothing of value is growing now, but it will also provide adequate protection for the soil and will retard run-off of water from melting snow and rain, thus making for a more even stream flow throughout the year. In addition to this, the greatest advantage will be that it will retain the many wood-using industries within the watershed, where the employment they provide will benefit all the members of the river valley community.

The free distribution of trees for planting was first begun in Ontario in 1905, and the following year a statute was passed which permitted a township council to exempt a part of the woodland of a farm from taxation; it provided that exemption be extended to any part of a farm used for forestry purposes or being 'Woodlands'; provided that such exemption shall not be greater than one acre in ten acres of such farm and not more than twenty acres held under a single ownership.

"'Woodlands' for the purpose of this paragraph shall mean lands having not less than four hundred trees per acre of all sizes, or three hundred trees, measuring over two inches in diameter or two hundred, measuring over five inches in

This is a private plantation of Scotch pine on light soil.

Plantations are not numerous on the watershed and extensive areas suitable for planting are few but a great many small areas exist of a few acres in extent which should be planted by private owners.

diameter (all such measurements to be taken at four and one-half feet from the ground) of one or more of the following kinds: White or Norway Pine, White or Norway Spruce, hemlock,tamarack, oak, ash elm, hickory, basswood, tulip (White wood); black cherry, walnut, butternut, chestnut, hard maple, soft maple, cedar, sycamore, beech, black locust, or catalpa, or any other variety which may be designated by Order-in-Council, and which said lands have been set apart by the owner with the object chiefly, but not necessarily solely, of fostering the growth of the trees thereon and which are not used for grazing livestock." - R.S.O. 1950, c. 24, s. 5 (18)

In 1927 the exemption of taxation on woodland was made compulsory if applied for, and is interpreted as meaning planted as well as natural trees.

In 1938 The Assessment Act was amended to prevent the assessment being raised on land after it had been reforested and now reads as follows:

"Land which has been planted for forestation or reforestation purposes shall not be assessed at a greater value by reason only of such planting." - The Assessment Act, R.S.O. 1950, c. 24, s. 33 (12)

Both these Acts were designed to facilitate the planting of trees on private land and should be taken advantage of by citizens anxious to improve woodland conditions on their own property and at the same time benefit the whole community of the river valley.

Within the Thames Watershed there are 272 private plantations, most of which are small, namely two to twenty acres in area. The largest are those of Dr. R.S. Murray in Downie Township which cover 120 acres.

The accompanying table shows the total numbers of trees distributed for planting on private land in the counties lying partly within the Thames Watershed since the Provincial Government first began to distribute trees for this purpose in 1905. The total number of trees is given as 6,093,000, but it is impossible to estimate how many were actually planted within the watershed. However, on the basis of an area an estimate of 3 million might be made.

The total acreage of private plantations of over one acre in extent existing today is 1,034 which would

TREES DISTRIBUTED FOR PLANTING

DEPARTMENT OF LANDS AND FORESTS FIGURES

PRIVATE PLANTING

YEAR	MIDDLESEX	OXFORD	PERTH
1905-1912	40,165	10,785	33,195
1913-1925	198,998	151,271	93,817
1926	114,998	82,464	61,522
1927	130,032	88,698	72,184
1928	161,082	152,971	95,747
1929	141,945	127,296	72,847
1930	214,326	156,119	111,312
1931	177,852	137,895	86,468
1932	306,721	243,637	85,589
1933	293,716	233,377	120,322
1934	212,736	218,526	88,839
1935	184,554	219,058	103,548
1936	316,103	274,464	105,687
1937	362,258	268,275	126,281
1938	272,920	316,044	83,590
1939	340,528	368,043	223,054
1940	327,733	407,948	121,971
1941	229,369	342,736	100,990
1942	341,579	272,510	98,430
1943	238,957	293,012	97,783
1944	217,729	211,535	64,683
1945	211,208	176,499	53,757
1946	301,399	274,181	96,992
1947	217,225	113,699	70,186
1948	232,948	251,007	69,746
1949	306,328	162,100	110,364
1950	379,671	225,331	171,904
TOTAL	6,473,080	5,778,981	2,620,790

COUNTY FORESTS AND OTHER MUNICIPAL PLANTING

YEAR	MIDDLESEX	OXFORD	PERTH
1913-1925	20,441	6,525	--
1926	1,150	--	--
1927	8,275	--	17,000
1928	2,850	9,000	1,775
1929	24,200	24,000	14,600
1930	11,200	15,000	46
1931	28,825	10,700	--
1932	18,317	10,689	375
1933	10,750	4,975	1,500
1934	18,250	7,000	450
1935	118,156	6,300	16,800
1936	11,938	1,600	12,300
1937	14,650	700	18,400
1938	78,625	1,300	14,500
1939	52,810	17,237	5,300
1940	8,956	11,500	1,300
1941	9,510	1,600	4,450
1942	17,950	9,700	4,200
1943	2,835	3,508	10,650
1944	10,516	60,700	15,700
1945	26,075	11,206	7,400
1946	76,275	144,250	9,250
1947	45,385	36,500	14,795
1948	9,975	13,850	150
1949	55,616	16,100	60,548
1950	69,234	41,275	21,405
TOTAL	752,764	465,215	250,084

TREES FOR SCHOOLS

YEAR	MIDDLESEX	OXFORD	PERTH
1933	675	--	424
1934	1,735	881	2,050
1935	786	370	875
1936	675	4,925	--
1937	34,836	19,010	78,782
1938	1,970	4,222	53,262
1939	5,853	36,740	23,993
1940	1,385	30,051	74,191
1941	5,401	37,953	11,905
1942	4,254	41,550	13,825
1943	5,786	216,410	172,672
1944	6,280	104,900	77,634
1945	1,985	141,556	86,734
1946	3.717	48.161	30.945
1947	193	3,460	--
1948	31,100	--	350
1949	--	725	1,231
1950	--	--	2,300
TOTAL	106,633	690,914	631,173

require 1,250,000 trees spaced 6 feet apart. If we take into consideration the fact that large numbers of the trees would be used for replacing losses on established plantations, for planting open areas in woodlots and for the establishment of shelterbelts and windbreaks, it is apparent that large numbers have been lost through various causes, chief among which are lack of protection from cattle, planting on soils unsuited to the species used and to lack of care of young plantations to eliminate competition from weeds and damage by mice. This loss is now being greatly reduced by a much closer examination of applications for trees and inspection of planting sites by the Zone Foresters.

2. County Forests

The County of Hastings was the first in the Province to interest itself in reforestation and as long ago as 1911 appointed a reforestation committee which was instrumental in having the Counties Reforestation Act passed which has since been incorporated in The Trees Act. The committee also recommended[1] that "The Corporation of the County of Hastings purchase from the municipality of the Townships of Elzevir and Grimsthorpe certain lands containing 2,800 acres, more or less, for $200" as the nucleus of a county forest. However, no further action was taken and the act lay dormant till 1922 when the present policy of county forests was laid down. The work is done under the authority of The Trees Act (R.S.O. 1950, c. 399), which provides for the purchasing of land and the entering into agreements by the county for the management of such lands. No limit as to the size of the area is stated, so that some counties have plots of a few acres while others have forests of several thousand acres. If, however, a county wishes to enter into an agreement with the Minister of Lands and Forests for the planting and management of such county-owned land, it is preferred that

1. Minutes of the Meeting of the Council of the County of Hastings, December 8, 1911.

the county purchase not less than 1,000 acres. The agreements which are in force at the present time run for a period of 30 years, during which time the Ontario Government agrees to establish the forest and pay the cost of such items as fencing, buildings, equipment, labour, maintenance, trees, etc. - in short, everything connected with the management of the forest.

At the end of the 30-year period the county has the privilege of exercising one of three options: First, to take the forest over from the Government and pay back the cost of establishment and maintenance without interest; second, to relinquish all claim to the forest whereupon the Government will pay to the county the cost of the land, without interest; third, the forest may be carried on as a joint undertaking by the Province and the county, each sharing half of the cost and half the profits.

It will be seen from the above summary of the agreement that all a county stands to lose on such a project is the interest for 30 years on the purchase price of the land. Also, it should be pointed out that, in drawing up such a liberal scheme, it was done purposely to encourage the reforestation of land not suited to agriculture. Again, it was not the intention of the Government to have the counties stop at a minimum of 1,000 acres, as the overhead necessary on an area of this size could very easily be spread over an area of five or even ten times the size. As a matter of fact this is what happened in some counties where the councils have initiated a progressive reforestation policy.

This Act also provides that municipal councils of townships shall have all the powers, privileges and authority conferred on councils of counties except that, instead of issuing debentures to an amount not exceeding $25,000 they shall have power to levy, by special rate, a sum not exceeding $1,000 in any year, for the purpose of providing for the purchase of land for planting and protecting the timber thereon.

The agreements which have been drawn up between the Thames, Humber and Ganaraska Authorities and the Ontario Government to establish and manage the Authority forests is substantially the same as that made with the counties, except that the Government has agreed to pay half the cost of the land and the agreement for planting and management is to run for approximately fifty years.

Oxford County now has the largest county forest in the Thames area, comprising 515 acres in five separate tracts. These are added to from time to time as land becomes available. Middlesex has 240 acres in three tracts. Forty acres were originally purchased in 1937 and two 100-acre tracts were bought in 1945.

PUBLICLY OWNED FOREST LAND IN THE THAMES WATERSHED

Forest	Tract	Township	Con.	Lots	Acres	
Conservation Authority	Ellice Swamp	Ellice	IX	11,12	150	
			X	10,12	150	
			XI	9,10,12	314	
			XII	8,9,10,11,12	495	
			XIII	8,9,10,11,12	495	
	Gads Hill Swamp	Easthope North	VII	37	101	
			VIII	36,37	100	
	Fish Creek	Blanshard	XI	20,21	66	
			XII	21	80	1,951
Oxford County	Banner	Oxford N.	VI	20	137	
	Chesney	Blandford	IX	5	100	
	Embro	Zorra W.	IV	15	113	
	Lakeside	Nissouri East	XII	27	78	
			XI	28	21	
	Macbeth	Dereham	III	24	66	515
Middlesex County		Dorchester North	I	13	100	
		Nissouri West	V	10	100	
			IV	1	40	240
Woodstock		Oxford W.	III	2		40
Stratford		Easthope North	I	44		8
St. Marys		Blanshard	XIX	19		10
TOTAL						2,764

A portion of the Gods Hill Swamp where the Authority will restore the tree cover by natural and artificial reforestation.

This is the former Perth County Forest now owned by the Authority.

Much of the remaining cover is poplar which will make pulpwood and improve the site for better species.

Perth County has, however, made no further acquisition to its original purchase of 100 acres in the Gads Hill Swamp and all the trees planted in 1945 are now dead. This land has recently been sold to the Authority.

3. <u>Upper Thames River Conservation Authority Forest</u>

Following the recommendations of the preliminary report prepared by the Department of Planning and Development in 1945, the Authority has acquired 1,951 acres of potential forest land, in the Ellice and Gads Hill Swamps and along Fish Creek which form the natural water-storage areas of some of the streams. Forty-four acres have been reforested along Fish Creek and a number of other areas are under consideration in the Authority's program of purchase and management of forest land at the headwaters.

4. <u>Municipal Forests</u>

Municipal forests are areas owned and managed by municipalities other than counties.

The three municipal forests in the Thames Watershed are: Woodstock 40 acres, St. Marys 10 acres, Stratford 8 acres; and the City of London has also done some reforestation work in the vicinity of its wells.

The town of Woodstock derives its water from wells near Cedar Creek south of the town. Forty acres in this vicinity are owned by the municipality and the planting of trees has been carried on periodically since about 1913. Most of the trees planted have grown well and the plantation is observed by thousands of people every year. It stands as a credit to the town and an inspiration to others; at the same time it is protecting the water supply and is a potential source of lumber. It could, however, be enlarged considerably.

St. Marys plantation, set out in 1927, is a small one, but the survival is good and there is considerable room for expansion on the banks of the tributary of Trout

Creek where the present plantation is situated. The area is close to the town and it is readily seen from Highway No. 7.

Stratford's small plot was planted by school children on land owned by the City, and could well be extended. In addition to this area, close to the city of Stratford are a number of kettle ponds, surrounded by slopes which undoubtedly help to maintain the level of the water table in the surrounding land. If some of these were acquired by the City, the slopes around them reforested and the areas made into municipal parks, urban and rural citizens alike would benefit. (See the Recreation section of this report.)

Assistance with regard to the establishment of municipal forests and the supplying of free trees is still the policy of the Department of Lands and Forests. Moreover, as provided by The Trees Act, (R.S.O. 1950, c. 399), it is possible for a township council to enter into an agreement with private landowners for the reforestation of their property. The agreement will prescribe the cutting conditions of all trees planted and such conditions will be subject to the approval of the Minister of Lands and Forests.

Provision is also made for exempting such lands from taxation and for making arrangements with the Dominion and Provincial Ministers of Labour regarding conditions of labour and payment of wages in connection with planting and conservation of such areas. - The Trees Act.

Before leaving the subject of municipally owned forests and forests which on a large scale would provide the local communities with at least a part of their livelihood, it would be as well to review what is being done along these lines in other places.

In Nova Scotia there is a community living on Hammonds Plains near Halifax, which depends entirely on wood taken from small woodlands for its livelihood. In this

the largest woodlot is not over 400 acres in extent and because of the rocky nature of the soil the people are not able to augment their incomes by farming, though most families own a cow, a pig and some chickens. The wood from the woodlots is manufactured into barrels and boxes by more than twenty small mills which are largely family-owned and -operated. The people are thrifty and industrious; they have comfortable homes, are public-spirited and extremely forest-fire conscious. This is a community which has developed naturally and yet resembles communities based on a forest economy which have been planned and established in Europe for a considerable time.

One of the most recent is the forest of Ae in Dumfriesshire, Scotland. It was established by the British Forestry Commission in 1927 and covers an area of 10,683 acres of which 3,000 acres have been planted, 4,500 acres are scheduled for planting in the near future, 250 acres of the best land have been set aside for cultivation, and the balance of 2,800 acres is unplantable because of its altitude but is used for sheep pasture in summer.

The forest is in charge of a forester who resides on the spot and under him there are foremen and gangs of workers. In the first year 16 men were employed, just before the war 27 full-time employees were engaged, and by 1960 about 90 men (or one man for each 80 acres) will be needed the year round for essential forest work. This does not take into account temporary employees who will be required for sawmilling, transport and other jobs. It is planned to create a forest village for the workers embodying a church, a school, playgrounds and sportsfields. The combination of the forest and the village dependent on it is something new in Scotland and represents an important stage in the resettling of men and women in the country. The village is to be the forerunner of other similar villages and in many parts existing villages will be revitalized by the stimulus of forest wealth.

5. Demonstration Plantations

In 1922 the Provincial Government began the policy of assisting municipalities in the establishment of small forest plantations for the purpose of demonstrating the use of trees on marginal and submarginal land. To meet the requirements for such a plot the Government required that the area be on a well-travelled road so that as many people as possible could see it; that the municipality either purchase land or use land which was in its possession, fence it, and agree to give the area reasonable protection after planting. In return the Government agreed to supply the trees and pay the cost of planting and of supervising the work when the planting was in progress. In 1932, when Government funds were curtailed, the policy governing these demonstration plots was changed, and from that time to the present the Government has not paid the cost of planting, although the other conditions governing the establishing of these plots have remained the same.

The only demonstration plot in the watershed was established by the London Kiwanis Club on city waterworks property on Highway No. 2, about one mile south of London, in 1929. It covered approximately seven and one-half acres of land and 11,000 mixed hardwood and spruce seedlings were planted. This plantation suffered the fate of many similar ones on heavy soil - weed competition was too great for the trees to overcome and more than 50 per cent were killed by mice girdling the stems.

The value of such plots, if well cared for, in showing landowners what can be accomplished in a very few years by planting trees is so great that every township should endeavour to establish at least one plot.

6. Demonstration Woodlots

Demonstration woodlots are privately owned areas of woodland on which the owners have agreed to follow pres-

cribed methods of woodlot management, outlined by the Department of Lands and Forests, under the Zone Forester and to permit access to the area by interested persons. Such demonstration woodlots and the influence they exert for the proper management of similar areas contribute to the total conservation effort in any watershed.

Twenty-nine demonstration woodlots have been established in the Upper Thames Watershed - 5 in Middlesex, 15 in Oxford and 9 in Perth County.

7. <u>School Forests</u>

In order to encourage the establishment of school forests planted and cared for by school children, the Ontario Horticultural Association in 1945 organized an annual competition. Prizes are offered for the school having the best plantation and knowledge of forestry in each forest district in Southern Ontario and for provincial winners from the winners in the districts. Prizes for these competitions are generously provided by the Ontario Conservation and Reforestation Association, Mrs. D.W. Boucher of Kingston and Mr. A.J. Jackman of Owen Sound.

Many schools in the area have entered these contests in the past and several schools have taken prizes in the district competitions.

Trees have also been sent out to schools in the watershed and have been distributed to children for planting on the home farm, and many of these have been used to form shelterbelts and windbreaks. The number of trees distributed for this purpose is shown in the accompanying table.

8. <u>Boys and Girls Forestry Clubs</u>

These clubs are organized by the Ontario Department of Agriculture assisted by the Department of Lands and Forests and must be sponsored by an organization interested in the improvement of woodland and reforestation.

Members must be between 12 and 21 years of age and each member undertakes a project such as marking a half-acre plot of woodland for thinning or reforesting a quarter-acre of land. Projects are judged annually on Achievement Day and prizes awarded; for this purpose the Department of Agriculture furnishes $3.00 per member and the sponsoring organization $1.50. Winners may enter the Provincial Inter-Forestry Club Competition.

The Counties of Middlesex and Perth each had one Forestry Club in 1950 and Perth came second in the Provincial Competition.

NATURAL WATER STORAGE AREAS
AND
REFORESTATION LAND

LEGEND

- AUTHORITY FOREST
- RECOMMENDED AUTHORITY FOREST
- COUNTY FOREST
- OTHER REFORESTATION LAND

1 ELLICE SWAMP	9 BLANDFORD
2 NORTH GAD'S HILL SWAMP	10 KOMOKA SWAMP
3 SOUTH GAD'S HILL SWAMP	11 NORTH DORCHESTER SWAMP
4 AVON RIVER	12 SOUTH DORCHESTER SWAMP
5 FISH CREEK	13 FOSTER, BEATTIE AND DINGMAN LAKES
6 TROUT CREEK	14 INGERSOLL SWAMP
7 MORAINE	15 CEDAR CREEK SWAMP
8 GILLESPIE SWAMP	

SCALE: MILES

CHAPTER 5

FOREST CONSERVATION MEASURES REQUIRED

1. Natural Water-Storage Areas and Reforestation Land

One of the most important conservation measures required on the Thames Watershed is the establishment of forest areas, to be called the Thames Forest, under the Conservation Authority which will serve to protect the natural water-storage areas of the valley. Fifteen such areas have been defined, as shown in the accompanying table, with the acreages of woodland, willow scrub, hawthorn, open land and water in each. The two-page map shows the location of these areas and the main tributary streams to which they supply water. The names given to these areas are taken from the streams they feed or from nearby places. The large folding map in the back gives more detail, showing the present tree cover, willow scrub, hawthorn and open land within the areas. The total acreage recommended for acquisition includes natural water-storage areas and reforestation land to the extent of 18,334 acres of which 7,621 have some form of tree cover, 2,811 are willow scrub or hawthorn, 7,690 are open land and 212 acres are water contained in small lakes or bogs. Of the 18,334 acres 1,951 have been acquired by the Authority and 100 acres are owned by Middlesex County.

In selecting the areas which it is felt should be set aside as permanent natural water-storage areas, adjacent swampland has been included irrespective of its present vegetative cover, that is, all soft maple and white elm woods, willow and dogwood thickets, bog land and marsh areas have been included. In addition, adjacent woodland, particularly on slopes and covering springs, has been included as well as adjacent land in moraines and gravel pits. The minimum of land in the better land classes has been included, but in some cases it was impossible to omit them entirely when they occupied positions immediately above springs or on a small part of a lot which was mostly composed of a poorer type of soil.

NATURAL WATER STORAGE AREAS

No.	Area	Wood-land	Open land	Scrub-land	Bog and Lake	Total
1	Ellice Swamp	381	462	39	18	900
	Authority Forest	997	32	516	65	1,604
2	North Gads Hill Swamp	436	74	17	-	527
3	South Gads Hill Swamp	662	184	167	-	1,013
	Authority Forest	60	26	115	-	201
4	Avon River	345	144	11	-	500
5	Fish Creek	39	603	282	-	924
	Authority Forest	36	80	30	-	146
6	Trout Creek	517	1,682	522	-	2,721
7	Moraine	776	1,824	453	7	3,060
8	Golspie Swamp	463	286	151	-	900
9	Blandford	808	860	223	49	1,940
10	Komoka Swamp	227	262	174	-	663
11	Dorchester Swamp	399	380	35	-	814
12	South Dor-chester Swamp	890	294	68	1	1,253
	Middlesex County Forest	100	-	-	-	100
13	Foster, Beattie & Dingman Lakes	146	238	28	67	479
14	Ingersoll Swamp	112	91	38	-	241
15	Cedar Creek Swamp	264	249	88	7	608
	Other Forest Tracts	4,139	11,921	2,779	67	18,906
	Totals	11,797	19,692	5,730	281	37,500

Some of the main tributary streams of the Thames arise in great swamps such as the Ellice Swamp which are the natural water storage areas and should be reforested.

Others arise as springs in pasture fields, here private owners should plant the surrounding slopes which are producing only sedge grasses and skunk cabbage.

of the area is impossible, but the poplar - willow stands around the margin can be greatly improved, the peat areas reforested and the submarginal farmland immediately surrounding it should be planted. In this way the area would also be made to produce a crop of economic value.

The total area recommended for acquisition here is 2,445 acres of which 1,341 are wooded, 493 are open, 530 are willow scrub and 63 are bog, too wet for trees. The Authority has already purchased 1,604 acres of this land but there are an additional 900 acres which should be included.

(2) North Gads Hill Swamp

This area is a comparatively small one draining into Black Creek through a large drain west from Highway No. 19. It includes 436 acres of woodland, 74 acres of poorly-drained marginal land and 17 acres of willow scrub.

(3) South Gads Hill Swamp

This swamp is one of the main sources of water for the Avon River. The stream which it feeds flows in the large drain beside Highway No. 19 and enters the Avon at the eastern outskirts of Stratford. The wooded area of the swamp encloses some vigorous springs and at least one pool where inflowing water apparently enters the ground, as there is no visible surface outlet. The area embraces 1,115 acres, 722 of which are wooded, 210 are open land which is largely sub-marginal pasture and 183 are willow scrub. The area has been mostly cut over though there are some stands of larger trees, chiefly white elm, silver maple and white cedar, particularly in the north end of Lot 36. The Authority has recently taken over the 101 acres of land here which the County of Perth purchased as the beginning of a county forest a few years ago and has bought another hundred acres, making a total of 201 acres owned by the Authority.

The Avon River above Stratford as it is to-day.

The Avon River as it should be. Stream bank planting will reduce erosion, keep the water cool and make the stream attractive in appearance.

(4) Avon River

The name Avon River has been used to designate two tracts north of Shakespeare from which two permanent streams flowing into the Avon River arise. The acquisition of these by the Authority for the maintenance of permanent flow is considered to be of primary importance. The more westerly of these streams rises as a spring in Lot 30, Con. VI, of Easthope North Township, and the easterly stream also rises as a spring in Lot 29, Con. V. The easterly one has a tributary rising in Lot 25, Con. IV. This last has its source in a small swamp on the height of land which supplies both this stream and a tributary of the Nith River with water. It has already been recommended that the Grand Valley Conservation Authority acquire the part of this swamp which lies in its watershed and its maintenance should be a matter of co-operation between the two Authorities. The two tracts constitute 500 acres with 345 acres of woodland, 144 acres of pasture and 11 acres of scrub land, mostly hawthorn.

(5) Fish Creek

Fish Creek is the name given to an area of about 1,000 acres close to where No. 7 Highway crosses this stream. Fish Creek itself flows in a former glacial spillway and for about four miles before it enters the North Branch of the Thames passes between steep banks which have been heavily grazed. The soil is gravelly in many parts, a number of worked-out pits are present and many acres are completely overrun with hawthorn. A long stretch of this valley is visible in both directions from Highway No. 7 and it would make an excellent demonstration forest; therefore, its acquisition by the Authority is recommended. It contains 968 acres, 75 of which are wooded, 603 open land and 290 are hawthorn scrub. The Authority recently purchased 180 acres here, 124 of which were subsequently sold, leaving a balance of 56 acres.

(6) Trout Creek

As most of the land in this area lies along Trout Creek the name of the stream has been used for the area. Trout Creek rises in the Zorra Swamp which also gives rise to the Main Branch of the Thames west of Tavistock. Most of this swamp lies in Lot 36 across the north end of the Townships of East and West Zorra. This lot is narrow all the way and comprises only about 120 acres in each concession; it is almost unoccupied and in most cases serves as an adjunct to farms in Lot 35, so that its acquisition should be a relatively easy matter. In addition to the swamp itself, certain rough land and steep slopes, mostly further down stream, have been included and their control by the Authority is considered vital to the maintenance of flow in these two streams. The whole area contains 2,721 acres with 517 acres of woodland, 1,682 acres of open land and 522 acres of scrub land, mostly willow.

(7) The Moraine

The moraine runs in a south-westerly direction from near Harrington West to the Cobble Hills and the word moraine has been used as the name for this area. The country is rough with steep hills; gravelly and sandy areas are separated by stretches of better farmland. The poorer tracts have been included in the area recommended for acquisition and in some cases are separated from each other as shown on the map. The moraine gives rise to many tributary streams in the form of springs and as much of it as is feasible should be under the Authority's control. Altogether there are 3,060 acres of which 776 are woodland, 1,824 are open land, mostly pasture, 435 acres are scrub and 7 acres bog or lake.

(8) Golspie Swamp

The Golspie Swamp covers an area of 900 acres, 463 acres of which are woodland, 286 are open land and 151 acres willow scrub. It lies directly west of Woodstock and

though it feeds a comparatively small stream which enters the South Branch of the Thames a little further down stream it is an important natural water-storage area.

(9) Blandford

The Blandford area is directly east of Woodstock in the Township of Blandford and is made up of imperfectly drained sand near the height of land which contains several small kettles. The land is submarginal due to poor drainage and though the growing of tobacco has been attempted on adjacent land it is at the northern limit of tobacco growing in this region and does not appear to be too successful. The land would be more easily reforested than any other in the Thames Watershed. It includes 1,940 acres with 808 acres of woodland, 860 acres of open land, 223 acres of willow scrub and 49 acres of water in the form of lakes and bog.

(10) Komoka Swamp

The Komoka Swamp is another swamp lying on the height of land. It is the source of a stream flowing north into the Sydenham River, and Crow Creek which drains into the Thames. This has been largely cut over and is now covered, for the most part, with scrub willow and aspen. In 1943 a cyclone blew down many trees, leaving a dense tangle in some parts. The tree species include elm, soft maple, white pine, white cedar and aspen, with red oak on the sandy land to the south, and white oak on the clay to the north. This has been a most important natural water-storage area and was for years a favourite haunt of naturalists, particularly ornithologists, in the London area before draining and clearing changed the habitat. Some tobacco growing and small market garden development are being attempted on adjacent land but most of the open land is suitable only for reforestation. The area includes 663 acres of which 227 are wooded, 262 are open land and 174 acres are willow scrub.

(11) North Dorchester Swamp

This is a swamp lying north of the Thames River which furnishes water to a small stream entering the Thames about three miles east of Dorchester Station. It contains 399 acres of woodland, 380 acres of open land and 35 acres of willow scrub.

(12) South Dorchester Swamp

Though this swamp is drained by a very short stream named Dorchester Creek it is the second largest water-storage area in the watershed and contains a greater number of tree species than the Ellice Swamp which exceeds it in area. It lies among the hills of the southern till moraine and is fed by numerous springs which rise on their slopes. The cover is mostly mixed woods, though areas of soft maple and white elm do occur. The County of Middlesex acquired the south half of Lot 13, Con. 1, of Dorchester North Township as the nucleus of a county forest in this area in 1945.

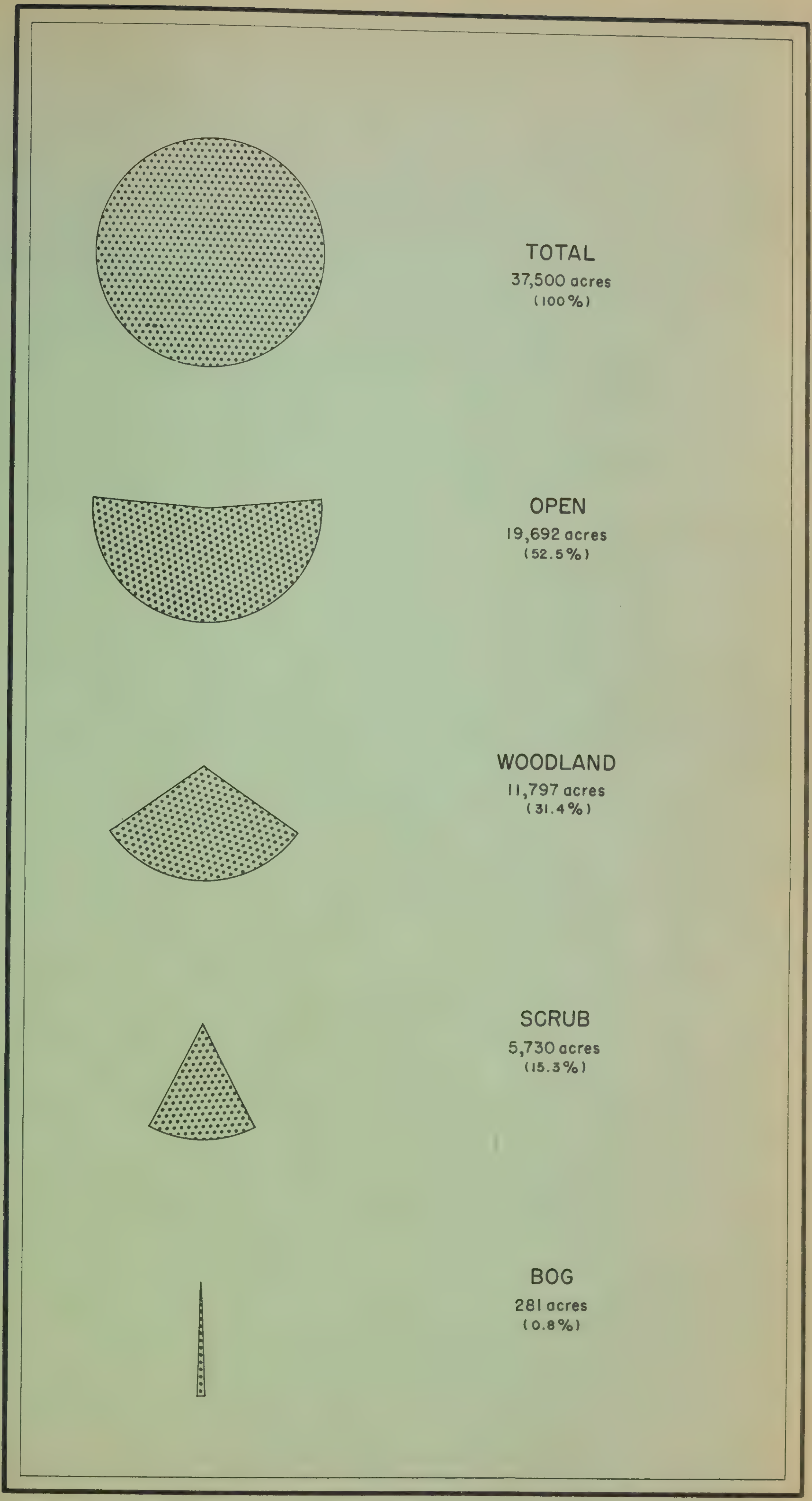
Included in the area are 1,253 acres with 890 acres wooded, 294 open land, 68 acres of scrub and 1 acre of water.

(13) Foster, Beattie and Dingman Lakes

These lakes or ponds are the headwaters of Dingman's Creek which drains approximately 100 square miles south of the city of London. The preservation of forest cover on the land surrounding them is considered to be essential to the maintenance of good flow. These tracts, recommended for acquisition, contain 479 acres with 146 acres of woodland, 238 acres of open land, 28 acres of willow scrub and 67 acres of bog and lake.

(14) Ingersoll Swamp

This is a small swamp containing many small springs which supply the reservoir from which the town of Ingersoll derives its water. This swamp should definitely



LAND CLASSIFICATION — AUTHORITY FOREST

INCLUDING LAND ALREADY ACQUIRED

be under public control to assure the maintenance of supply and purity of the water. It embraces 241 acres, 112 acres of which are wooded, 91 acres are open land and 38 acres are willow scrub.

(15) Cedar Creek Swamp

This area comprises 608 acres in all with 264 acres of woodland, 249 acres of open land, 88 acres of willow scrub and a pond of seven acres. It is one of the main sources of water for Cedar Creek and a number of very strong springs arise here. It includes 40 acres of swamp land which were acquired by the City of Woodstock in 1910 to protect its water supply which is piped from here. Considerable reforestation has been done on the land adjoining the swamp and, as the property is situated on the highway, it serves the triple role of conserving water, beautifying the landscape and as a demonstration plantation. The area recommended would take in the whole swamp, the mill pond on Cedar Creek, some of the surrounding dry land from which the springs flow and the natural storage basin for the waters of the creek.

Restoration of the forest cover to the land in all these areas would not only serve to protect them, slowing down run-off from the slopes and holding water in the natural water-storage areas of the swamps, but it would greatly improve the economy of the whole region by growing timber on land which is otherwise largely unproductive, thus providing work for the local people.

2. Other Forest Tracts

In addition to the fifteen major source areas there is a large number of small isolated tracts similar to those constituting the Oxford County Forest where the land is submarginal. These could and should be taken up as they become available and included as parts of either the Authority or county forests. They are shown on the Forestry map dis-

tributed throughout the watershed. Many embrace no more than 100 acres but in the aggregate make up a considerable acreage of potential woodland which should materially improve water relationships in the watershed. These tracts total 18,906 acres in area with 4,139 acres of woodland, 11,921 acres of open land, 2,779 acres of scrub and 67 acres of marsh.

3. <u>Scrub Land</u>

The total area of scrub land on the Upper Thames Watershed is 20,876 acres of which 12,575 acres are dry scrub and 8,292 are wet scrub. In other words one acre in every forty is scrub land and absolutely non-productive. This is in the centre of the most highly productive agricultural area of Southern Ontario.

Scrub land has been placed in two categories: dry-sited scrub which includes such species as hawthorn, apple, sumach and witch hazel, and wet-sited scrub - willow, dogwood and alder. Dry-sited scrub land is usually land which has been overgrazed and neglected for many years. The soil may be unsuited to agriculture because of poor quality, excessive steepness or inaccessibility. On the other hand it may be fairly good farmland which the owner has not been able or willing to maintain in good pasture so that shrubs whose seeds are spread by birds and which are unpalatable to cattle have taken over the area.

Wet-sited scrub land is land with imperfect drainage, often bordering swamps. The bush has been cleared from it but the subsequent pasture has been so poor that shrubs such as willow and dogwood, which require a damp site, have invaded the area.

Frequently scrub areas of these two types are only suitable for trees. They should be reforested and the acquisition of some of them by the Authority has been recommended. The wet-site areas present a problem in planting, and research should be undertaken to determine the best

In the Upper Thames Watershed two and a half per cent of the area or one acre in every forty is covered with scrub growth.

In a very few years these become "jungles" where not even trees can secure a foothold. The owner must decide whether he is prepared to clear the area or kill the scrub and plant trees to smother it.

method of handling them. There appears to be a natural succession from neglected pasture land, through willow scrub, trembling aspen, white elm and black ash to the climax types of silver maple - white elm or black ash - white elm - red maple, and every effort should be made to determine the best method of speeding up this succession.

In addition to the larger areas there are innumerable smaller areas forming parts of farms which will always be in private hands. The aggregate effect of this on stream flow is very considerable. The scrub areas of this type are shown on the forest map and the moraines and glacio-fluvial material are defined on the soil maps. These should be planted with trees to form part of the farm woodlots where they occur. Many of them should be placed under a reforestation and controlled woodlot scheme by agreement with the Authority, especially where they cover the sources of streams. Under this scheme the owner would get considerable help from the Authority in the establishment and maintenance of the woods, but would not be permitted to cut them indiscriminately. (See Controlled Woodlot Management)

4. Controlled Woodlot Management

Before the necessary conservation measures on that part of the watershed exclusive of the proposed Thames Forest can be properly co-ordinated, some system of controlled cutting of privately owned woodlots must be established. The reason for this is that the average owner does not take a broad view of the value of forest cover and is not interested to any great extent in what may happen to land or stream flow off his property. The result is that throughout the watershed there is a systematic cutting of woodlots for the purposes of lumber and firewood. The type of cutting has been in progress for many years, and the portable sawmill has done a great deal of damage in removing, particularly, young, thrifty trees. The system of selling acre or half-acre

blocks of timber for fuelwood is also another vicious practice, for the reason that when a purchaser buys such a block, in nearly every case he clean-cuts every tree which can be used, down to the minimum diameter limit. Some system of regulating cutting would correct this situation and certainly the areas which are connected in any way with the headwaters of streams, or the feeding of springs, should be controlled to the extent that they cannot be clean-cut.

Where conditions warrant, cutting would be continued, but should be controlled by agreement with the Authority and only such trees as are marked by a competent person should be cut. Provision should be made for re-stocking, where necessary, the intention being to interfere as little as possible with the economy of farm property where the supply of wood is concerned. County by-laws restricting cutting passed under The Trees Act do not prevent an owner from clear-cutting any area if the wood is for his own use.

For many years now conservationists have advocated controlled cutting of woodlots. In some sections, particularly in tobacco-growing counties such as Norfolk County, the destruction of woodlots for the curing of tobacco has become alarming. It is admitted that the question requires delicate handling, but where the good of the whole community is envisaged some middle road of agreement could be arrived at. Furthermore, the distribution of free trees by the government for conservation purposes is sometimes criticized, and rightly so, where on one farm the owner plants an area with seedlings and in the same year his neighbour clean-cuts a woodlot which perhaps protects the headwaters of a stream. In fact, so distorted is the relative value of plantations versus established woodlots in the minds of some people that there are examples on record where municipalities have purchased land for reforestation and have allowed the owner to cut the timber before giving title.

It is admitted, of course, that there are extenuating circumstances when a farmer may consider it necessary to raise money by selling timber. This in itself is not so serious if the cutting is done in such a way that the benefits of the forest are retained. Young forests, as well as old, protect the soil and have water-regulating value.

The basis on which a regulation of this kind should be carried out is a consideration of the woodlot concerned. To make a blanket ruling that all woodlots on the Thames should not be cut, or should come under one type of control measure, would not work to the best advantage of the community and certainly would not be in the interests of good forestry.

Some woodlots have reached the stage at which they are worn out and if the land is good should be cleared off and cropped. Others may be composed of a high percentage of worthless species and have no relation to water regulation in the countryside, and likewise could be disposed of to advantage. But where the woodland has a direct bearing on water regulation, erosion, retarding of the wind and similar benefits, the desire of the individual should be sacrificed for the good of the community. The whole question, therefore, resolves itself into an examination of each woodlot by a competent person, and the prescribing of a program of management to suit each case.

5. Fencing Woodlots From Cattle

The most progressive forestry action taken in Southern Ontario in recent years was taken by the County of Halton in 1948 when the County Council passed a by-law to aid farmers in fencing their woodlots from livestock.

The by-law states that the County of Halton will grant a sum equal to the prevailing cost price of 8-strand fence wire with a single barb (not the cost of posts or labour) to a woodlot owner who will erect such a fence on one or more sides of his woodlot in order to completely enclose the woodlot, thus fostering forest growth by keeping

This beech-sugar maple woodlot is heavily grazed and all regeneration as well as the natural covering of the forest floor has been destroyed.

Natural regeneration can be secured by fencing the area from cattle and breaking the sod cover by discing in the fall before the trees seed.

COUNTY BY-LAWS RESTRICTING THE CUTTING OF TREES UNDER THE TREES ACT

County	Date Passed	Diameter Limit (inches)	
		Cedar & Certain Species	Most Species
BRANT	Nov. 2/48	5	14 Stump 18"
BRUCE [1,2]	Jan. 23/48	6	12 Stump 18"
DUFFERIN [3]	Nov. 28/47	5	12 Stump 18"
DURHAM [4]	June 12/47	5	10 D.B.H.
ELGIN [5]	Jan. 24/47	5	12 D.B.H.
GREY [2] (except Keppel Tp.)	June 27/47	6	12 Stump 18"
HALDIMAND [2,6]	May 13/49	6	14 Stump 18"
HALTON	Apr. 15/47	7	14 Stump 18"
HURON	Nov. 21/46	5	12 D.B.H.
LAMBTON	June 12/48	7	12 Stump 18"
LEEDS/GRENVILLE [7]	June 21/47	0	0
MIDDLESEX	Mar. 12/47	6	14 Stump 18"
NORFOLK	Jan. 23/47	6	14 Stump 18"
OXFORD	Sept.13/46	5	12 D.B.H.
PERTH	Jan. 25/47	5	16 D.B.H.
WATERLOO	Oct. 23/46	5	14 D.B.H.
WELLINGTON	June 15/46	5	12 D.B.H.
WENTWORTH	May 12/49	6	14 Stump 18"
YORK [8]	Nov. 18/49	0	14 D.B.H.

D.B.H. is diameter breast high or 4½ feet above ground.

1. Limits apply only in the south half of Bruce County.
2. Bruce, Grey and Haldimand also have an 8-inch limit for poplar and birch.
3. Dufferin has a 10-inch limit on basswood.
4. Durham also has a 5-inch limit for birch, black locust, black ash, soft maple, tamarack and willow.
5. Elgin has a 5-inch limit for black locust.
6. Haldimand also has the following: 8-inch limit on cherry, 10-inch limit on birch, 12-inch on basswood, chestnut, coffee, cucumber, gum, hackberry, sycamore, hemlock and tulip.
7. Leeds and Grenville have imposed no limit and the by-law is almost worthless from a forestry point of view.
8. York has no limit on poplar, Manitoba maple, black locust, tamarack, white birch and willow.

livestock out. The woodlot must be of a size not less than two acres and livestock must be excluded for a minimum period of ten years.

Such action by the County Council is of infinitely more value than the planting of many millions of trees artificially. Every county should pass such a by-law and it is recommended that the Conservation Authority adopt a similar scheme.

6. <u>Diameter Limits</u>

The basic method of control usually advocated is cutting to a diameter limit; that is, that all trees below a certain diameter - for example, ten inches - should not be cut. Such a regulation may or may not be good forestry. In most cases it would not be because there would be much worthless material below this diameter limit, such as poplar, thorn, willow and other species, which should be taken out. At the same time there would be certain large trees above the diameter limit which should be left for the benefit of the forest, as well as trees suitable for reseeding the area. The diameter limit should not be a fixed rule but simply a guiding principle; a sort of yardstick on which the landowner can base his calculations. In an area the size of the Thames Watershed a program of individual woodlot examination should not be too heavy a burden on the Conservation Authority.

Nineteen counties, including the three covering the Upper Thames Watershed, have passed by-laws under The Trees Act (R.S.O. 1950 c. 399) which empowers a county council to pass by-laws restricting and regulating the cutting of trees. In each case the by-law has fixed minimum diameter limits below which trees may not be cut except in special circumstances. The object of this is to prevent the cutting of trees at the time when they are putting on their greatest diameter growth. These limits are usually 5 or 6 inches for white cedar, red cedar and black locust and range from 10

Clear cutting of woodlots as practised in the past created non-productive weed patches.

Similar areas cut under the diameter limit by-laws of the counties soon regenerate themselves if cattle are excluded.

inches to 16 inches in the various counties for all other species. The limits which have been set are actually far too low for the final crop trees as most trees are making their maximum diameter growth after they reach 18 inches in diameter, but it is an elementary step in the right direction. Every county should have restrictions of this type and it is recommended that similar powers be extended to Conservation Authorities as a means of protecting existing woodland on their watersheds.

7. Forest Fire Protection in Southern Ontario

The task of protecting woodlands from fire in Southern Ontario presents a very different problem, or rather series of problems, from those of Northern Ontario, and consequently must be handled in a somewhat different manner. Though fire is a serious question on the Thames Watershed only in certain areas such as the Ellice Swamp, it is a question to which some attention should be given.

Northern Ontario is predominantly forest land, the population is sparse, parties travelling through the forested areas are fairly readily accounted for by means of a permit system during the fire season, and watch is maintained for fire by means of look-out towers and air patrol.

In Southern Ontario south of the Laurentian Shield the land is normally potential agricultural land with the woodland surviving in isolated patches as farm woodlots or in larger more or less continuous blocks of swamp or sand up to ten thousand acres in extent. The population is, relatively speaking, fairly dense, no part of any woodland is more than two miles from the nearest human habitation and most roads are travelled by a comparatively large number of people.

In spite of the publicity given to the damage caused by fire the average person does not realize how serious this is. Though he may know that young growth and small trees

are burned by surface fires he does not realize the extent of the less obvious damage such as the destruction of humus which itself preserves the condition and water-retaining capacity of the soil. When the humus and ground cover are destroyed the sun and dry winds remove the moisture required for tree growth and plant nutrients are destroyed. The heat of the fire also injures the growing tissue inside the bark of older trees which are not actually burned, exposing the wood to attack by insects and fungi. Even though through time the wounds may be completely healed, the damage shows up as defects when the tree is cut for lumber.

Many farmers in Southern Ontario are so completely unaware of, or indifferent to, the damaging effects of fire that they deliberately set fire in peat land to burn off the peat, starting fires which it is next to impossible to extinguish. Such fires burn for months, even under the snow, destroying many acres of woodland every year, not only on the land of the person setting the fire but frequently spreading over land adjacent to it.

The first step in fire control is fire prevention, and the best assurance of prevention is an enlightened public opinion which will make every member of the rural community conscious of the seriousness of fire damage and of his duty as a citizen to do all he can to prevent it. The farmer can prevent most fires in farm woodlots if he exercises the same care that he does around his home and buildings.

Experience in the United States has shown that the most effective fire protective systems in rural districts are those set up under a state organization with local wardens appointed by the state forester on the recommendation of the local town[1] councils. In the rural parts of the state of Maine each town appoints its own fire wardens who handle fire protection in the town quite independently of other towns. This means there is a lack of co-operation between towns, wardens receive little practical training, organization is

1. The "town" in the Eastern United States corresponds closely to the township in Canada.

loose, and as wardens hold office at the pleasure of the town council there is a serious lack of continuity in administration.

In New Hampshire and Vermont wardens are appointed by the state forester on the recommendation of the council and in Vermont they serve until they resign or are removed for cause by the state forester.

Mr. H. H. Chapman, writing in the Journal of Forestry, states [1]: "It is not unreasonable to conclude that the ratio of 34 to 1 in damage per acre of woodland between these two states (Maine and New Hampshire) is the direct consequence of Maine's failure to depart from the 'fire bucket' principle of town organization".

From the evidence collected in the northern states of the United States, where conditions most nearly approximate those of rural Southern Ontario, it is apparent that the most effective fire protective systems are those set up under the following conditions:

(a) Where the system is organized under the direction and control of the state forester and the wardens in each town are appointed by him on the recommendation of the local council.

(b) Where wardens paid an annual retainer are actual residents in the locality. Usually they are farmers who have had practical instruction in fighting fire. They have the power to call out other local residents to help in firefighting and maintain a store of firefighting tools on their premises.

(c) Where the warden is assisted in his work by all members of the community. That is, his address and telephone number are known to everyone and fires are reported to him immediately.

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1. Journal of Forestry, Vol. 47, No. 2, 1949.

(d) Where designated members of the community know that they are likely to be called on to fight fire and are paid so much per hour for the time they are so employed.

(e) Where every resident is thoroughly fire-conscious and realizes that loss of timber by fire is a loss to the whole community, and considers it his duty to prevent, report and fight fire.

(f) Where fires for burning brush and rubbish may be set only after a permit has been obtained from the local firewarden.

CHAPTER 6

FOREST INSECTS AND DISEASES

1. Forest Insects

In any project, such as that proposed for the Thames Watershed, careful consideration should be given to the prevention of insect outbreaks and adequate arrangements made for the immediate application of control measures when these become necessary. While it is not possible to predict accurately the course insects may take under the ever-changing conditions of a newly forested area, there are a number of fundamental principles which, if applied, will greatly lessen their destructiveness.

It is important to avoid the planting of large areas of one kind of tree, otherwise conditions will be ideal for an outbreak of abnormal numbers of some insects which prefer the food afforded by that particular host. It is preferable to plant in blocks, the blocks distributed so that trees of one species are separated by blocks of different tree species. This tends to keep outbreaks localized until natural agencies bring them under control and facilitates direct control measures if such become necessary.

It is important to plant only the species of trees suitable to the site and existing growing conditions. Healthy, vigorous trees are certainly more resistant to insect attack than weak, struggling ones.

Over-mature and dead trees should be removed from the existing stands as these harbour bark-beetles and wood-boring insects which may become excessively abundant and attack healthy adjacent trees.

Care should be exercised to prevent ground fires. Even light ground fires are frequently followed by severe outbreaks of bark-beetles and wood-boring insects.

Woodcutting operations, sawmill sites and wood storage yards should be carefully supervised or they may become reservoirs of infestations.

It is essential that surveys for insect conditions be made each year so that any abnormal increase in insect populations may be noted and control operations initiated before they develop to outbreak proportions. Serious and widespread outbreaks are frequently prevented by prompt and well-timed spraying operations over a comparatively small area. It is therefore necessary that spraying equipment be available and that laneways be maintained within the plantations for spraying purposes. Outbreaks of an extensive nature can generally be brought under effective control by strip spraying. In this method, alternate strips of trees in large plantations are sprayed, thus reducing the initial infestation and at the same time causing the native parasites to concentrate and build up in the unsprayed portions. This reduces spraying operations and the number of lanes required for the passage of spraying equipment.

Owing to the danger of injury by the white pine weevil, white pine should not be planted in pure stands unless the stands are very densely stocked in a good site. It is better to grow white pine in mixture with some immune species such as the better hardwoods. The protecting species should be taller than the white pine, at least in the early years.

In conclusion, it should be recognized that protection against leaf-feeding insects is very desirable since defoliation of a tree weakens it and thus makes it more susceptible to attack by bark-beetles and wood-boring insects as well as by organisms which do not usually attack healthy trees but which will hasten the death of weakened trees. Leaf-feeding insects alone may kill a thrifty, broad-leaved deciduous tree by completely defoliating it for three years in succession. Conifers, however, are usually killed as a result of one complete defoliation.

2. Tree Diseases

Productive woodlands require protection against fire, trespass, grazing animals and rodents, insects and

This is a sweet chestnut log near Lakeside. The Chinese chestnut blight wiped out this species some years ago and now only fence rails and a few sickly suckers remain.

Tree diseases may do considerable damage in woods which are not maintained in a sanitary condition by the removal of diseased trees. These trees are infected with the poplar canker.

disease. Protection is a part of forest management, and under a policy of sustained yield will be maintained in continuity. Good forest management is reflected in the health of the woods and, conversely, damage on account of disease is often a sign of mismanagement or neglect. In general, an objective of maximum yield, with attendant intensive silviculture, is compatible with, and often facilitates, protection and disease control.

For the purpose of discussing their pathology and protection, the hardwoods may be considered separately from pine in natural stands or plantations. The chief diseases of the hardwoods are the various trunk, butt and root rots, and chronic stem cankers, which are all endemic and may cause serious damage under aggravating conditions. Woodlots on the Thames Watershed present very diverse conditions with respect to the incidence of these diseases, a circumstance which is usually related to their past history. Thus many containing old timber are in need of heavy preliminary salvage and sanitation cuttings as a result of mismanagement or neglect. Such cuttings should precede or be combined with cleanings and improvement cuttings, designed to improve the composition and structure of the stands. Having established a sanitary condition, normal care should maintain it and obviate loss on account of decay.

The wood rots are commonly thought of as diseases of mature and over-mature timber, but experience has shown that infection may occur at a very early age. In hardwood sprouts the stem may be infected from the parent stump. In older trees infection is chiefly through wounds, either of the root or trunk, which may be caused by fire, trampling by animals, insects, meteorological agencies, or by carelessness or accident in felling and other woods operations.

Hardwoods are commonly cut selectively and not infrequently in clear fellings. Few foresters will approve the latter system, which is in fact often intended as a liquidation of the property. A system based on yearly selection,

or frequent periodic return to conveniently planned subdivisions, has obvious advantages for small woods, and is well adapted to the control of decay.

For many reasons "cleanings" in the reproduction are desirable, especially where the woods have been heavily cut. While favouring the valuable species, those sprouts which, on account of decay hazard, are of undesirable origin should be eliminated. Such will comprise sprouts from the larger stumps and those from above-ground position.

In harvest cuttings, which should recur at frequent intervals, the permissible volume allotted should include trees in which incipient decay is discovered and so far as possible those which have become a poor risk through injury or other circumstances.

White pine is found in young plantations and in natural stands, almost pure or mixed with hardwoods. From the latter stands it tends to disappear on account of hardwood competition, except on sites which are particularly favourable for its reproduction. The white pine blister rust, which with the well known shoot weevil is a principal enemy of the species, is a factor contributing towards the elimination of seedlings and young trees.

White pine should be encouraged on those sites which are naturally suited to its reproduction so that fairly compact growth may be secured, thereby facilitating the protection problem. It is an important and valuable species in Southern Ontario, and its cultivation should be promoted by the institution of effective blister rust control facilities.

CHAPTER 7

LAND ACQUISITION

The problem of land acquisition in any part of agricultural Ontario, where practically all the land is privately owned, is one which requires careful approach. The ownership and use of land, especially for agricultural purposes, is considered by most citizens as one of their few remaining inalienable rights. However, where the good of the whole community is under consideration, such personal rights should be, and have been, overruled under the principle of eminent domain. Examples of such cases are the building of highways, the construction of power lines, and the acquiring of land for military purposes in the event of a national emergency.

In Southern Ontario compulsion has not been exercised to any great extent by the Government in planning proper land use schemes. But who would gainsay the fact that the acquiring of poor land on the Upper Thames Watershed for conservation purposes constitutes a national emergency, and therefore requires a more permanent authority than the individual to bring it back to its proper use.

However, in dealing with land acquisition it should not be the desire of any authority to approach the problem in a dictatorial manner. It will require careful handling, and as a preliminary step in such work the people of the area should be acquainted with the purpose of the scheme, its ultimate benefits to the community, and by explanation and demonstration be gradually brought to the point where they will be glad to co-operate.

The only part of the Upper Thames where large-scale transfers of property from private ownership to a forest authority would have to be made is in those areas which are recommended for acquisition because they are natural water-storage areas.

1. Methods of Acquiring Land

There are several ways in which land can be acquired and controlled for conservation purposes, and it is proposed to enumerate and discuss these briefly in this section.

(a) Transfer by Private Sale

The most satisfactory method of acquiring land is by private sale between the Conservation Authority concerned and the landowner. This method has been followed by the counties of Ontario in purchasing land for reforestation work in building up the system of county forests, which totals in round figures 65,000 acres. This method has its drawbacks, however, as individuals who have not the community's welfare at heart, or for one reason or another have an exaggerated idea of the value of their property, may block the completion of a unified area by refusing to sell. This was overcome in the State of New York, which has purchased over 450,000 acres of land for reforestation, by refusing to buy individual parcels of land unless there was a sufficient number in a group to make a contiguous block of 500 acres.

(b) Maximum Price per Acre

Another method which has been used has been to fix a maximum price per acre for this class of land, beyond which the forest authority is prohibited to go, allowance being made for the presence of good fencing and buildings on the properties, which in some cases have been removed by the vendors and allowed as part payment for the land.

(c) Agreements

Where owners of property prefer to retain their woodlot, or where parts of farms fall within the forest area prescribed, and providing the retaining of ownership does not jeopardize the complete conservation scheme, agreements could be made for the control and

management of such areas.

This method has been adopted by the Dominion Forest Service in Nova Scotia, where it has been desirable to control wooded areas for experimental and conservation schemes, and in this particular case the agreements cover a period of twenty years.

In Ontario there is one example, at least, where a municipality leased a part of a farm for reforestation work for fifty years, and one United Counties council has adopted the plan of taking easements on land for the same purpose.

(d) Control by Existing Legislation

Under the authority of the Private Forest Reserves Act (R.S.O. 1950, Chapter 288), the Minister of Lands and Forests, on recommendation to the Lieutenant-Governor in Council, may, with the consent of the owner of any land covered with forest or suitable for reforestation, declare such an area to be a private forest reserve. When such an arrangement is made the Minister or his representative may reforest such areas, supervise the improving and cutting, and prohibit the removal of trees by the owner without his consent, and also prohibit the grazing of the area by cattle.

(e) Life Lease

Many of the farms on the proposed forest, as already mentioned, are of low agricultural worth and are supporting families at the present time. The problem in such cases is not so much the purchase of the property as what will become of the family after the farm is acquired. In almost every case it would be impossible for the vendor to purchase another farm with the money he receives, except one which is of approximately the same value outside the forest. In some cases such farms are occupied by older people whose families have grown up and left the community. The removal of these from their properties might work undue hardships on them, and in fact in some cases they might be-

come a burden on the municipality. With some of these the plan of giving the vendor a life lease would be sufficient. In most cases such old people make little attempt at farming the whole property, but require only sufficient pasture for a cow or two, enough land for a garden, the house and buildings, and a supply of fuelwood. The plan of giving a life lease has been adopted in the case of two properties,[1] at least, on the county forests in Ontario, and has proved satisfactory to both contracting parties.

(f) Tax Delinquent Land

Under the Statutes of the Province of Ontario,[2] land which becomes tax delinquent is sold by the County Treasurer. In the case of a farm this is not done in practice until the land has been in default for three, or in some cases four, years. Even then the owner has the privilege of redeeming his property within a year. Where such lands are marginal or submarginal, they are sometimes bought for only a part of the area which is of special value, such as woodland, old buildings, or a good field or two. In some instances the poor land remains idle and frequently appears again at the tax sale. The fact that such land becomes tax delinquent is an indication in many cases that its ultimate use is forestry. Under the present Statutes the municipalities are not permitted, at the first sale at least, to acquire or reserve such land for conservation purposes. Consequently this report recommends that the Authority expropriate all tax delinquent land subject to the regulations of the Municipal Act.

(g) Expropriation

As a last resort in land purchases, or where the owners of abandoned land cannot be located, such areas can be acquired by expropriation. The Conservation Authorities Act, R.S.O. 1950, Chapter 62, Section 15 states:

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1. Northumberland Forest and Angus Forest.
2. The Assessment Act, R.S.O. 1950, c. 24, s. 143.

"For the purpose of carrying out a scheme an authority shall have the power to purchase or acquire and without the consent of the owner enter upon, take and expropriate any land which it may require and sell or otherwise deal with such land or other property."

Also under The Forestry Act (R.S.O. 1950, Chapter 147, Section 13) provision is made for the removal of settlers from lands unsuitable for farming. To quote: "Whenever in the opinion of the Minister, it is found that settlement has taken place on lands not suitable for agricultural purposes, and which said lands are required for forestry purposes, the Minister shall have the power to make arrangements for the removal of such settlers upon such terms as may be agreed upon."

As a matter of general interest, it should be stated that this Act also provides for the power to close the roads on lands taken over for forestry purposes, the setting apart of lands for settlement, and the removing of settlers from lands unsuitable for farming. It should also include, however, provision for acquiring permanent or community pastures, and pondage areas where these are required, as an integral part of a large conservation project.

2. Cost of Land in the Proposed Authority Forest

It would be impossible to give an accurate figure for the total purchase price of all land in the proposed forest without consulting the owners of the individual parcels. However, as an indication for arriving at the approximate cost the amounts paid by the several Conservation Authorities of the Province in purchasing land for their forests will serve as a guide.

TABLE SHOWING COSTS OF LAND PURCHASED FOR FORESTS

Name of Authority Forest	Acres	Cost $	Cost per Acre $
Ausable	634	12,700.00	20.03
Ganaraska	3,253	22,078.00	6.78
Humber	411	11,795.00	28.70
Thames	1,980	10,870.17	5.49
Total	6,278	57,443.17	9.15

It should be pointed out that land acquired in the future by the Ganaraska Authority is likely to cost more than the average price per acre of $6.78 because most of the poorest denuded land has now been taken up and the remainder has more woodland and potential woodland which will naturally raise the purchase price. The very low cost of land in the Thames Watershed is explained by the fact that it is mostly burned-over swamp land with a peat soil which is of no economic value at the present time. Actually the average price of $5.49 per acre includes a ditch tax which exists as a lien against part of the property, so that the price of the land itself was closer to $1.00 per acre.

On the Thames Watershed, too, most of the poorest land has now been acquired and the cost of the remainder will certainly be higher. The development of a comprehensive conservation program is a long-term project and it may be fifty years before the Authority has all the land required. The present policy of acquiring and

reforesting some land each year is a sound one, and where the cost of certain areas is too high the Authority can afford to wait, because the land is deteriorating in productiveness through cutting, fire, grazing and neglect and eventually the price must fall too.

CHAPTER 8

SNOW FENCES

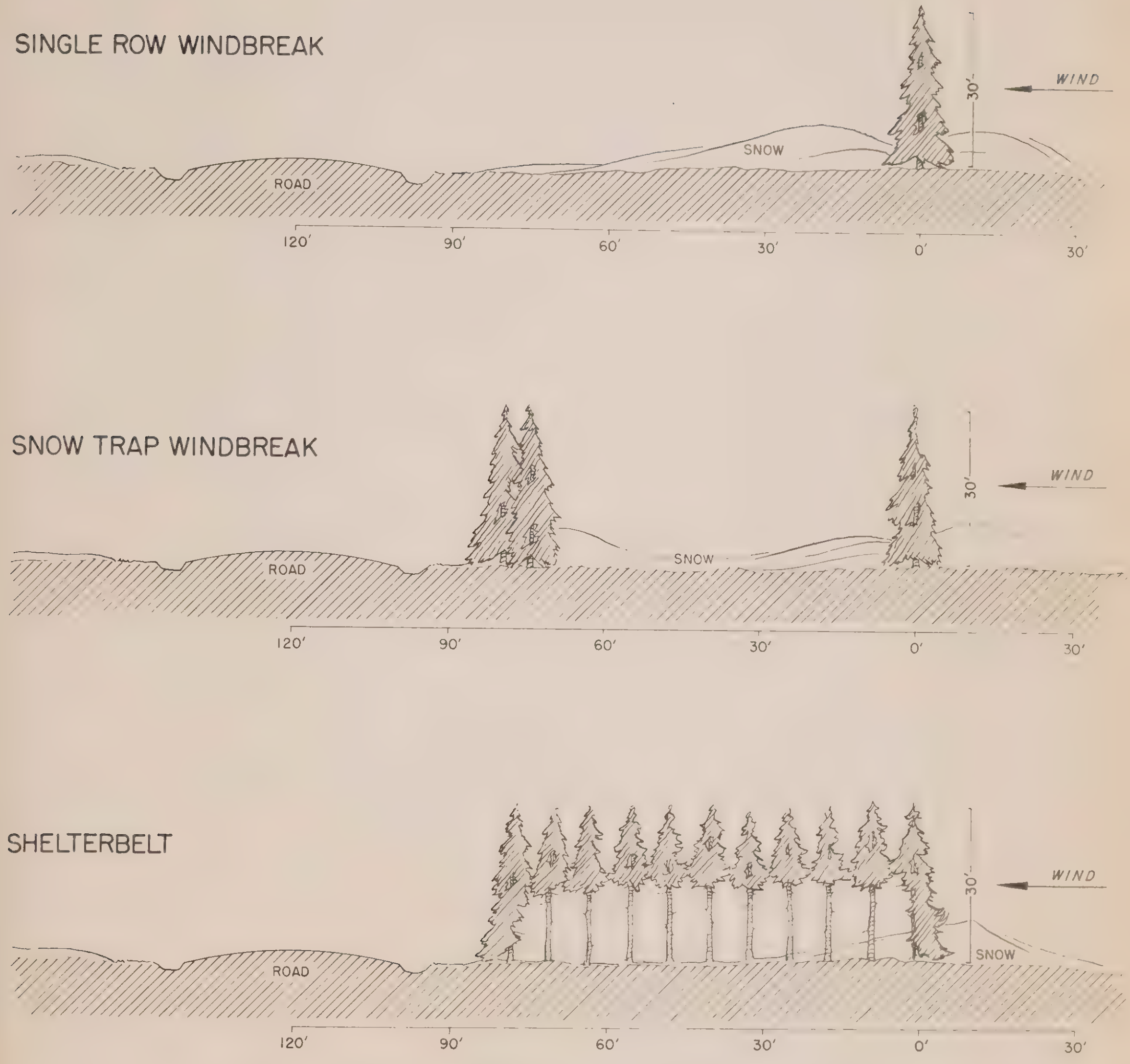
In the climate of Southern Ontario snow drifting may cause much inconvenience and sometimes hardship. Control can be readily effected by means of windbreaks and is dependent on proper placing with reference to lanes of travel and topographic features.

Where space is limited or land valuable lath or board fences are frequently used, but the cost of erection, removal or maintenance of these can be materially reduced by using trees as permanent windbreaks or shelterbelts. One or two rows of trees are usually referred to as a windbreak and more than two rows as a shelterbelt. The latter is preferable if space permits as it gives better and more permanent protection.

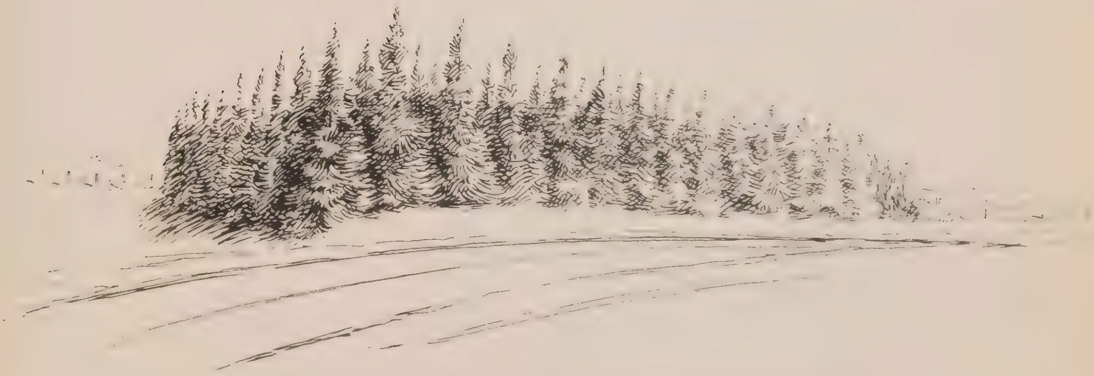
The prevailing winds in Southern Ontario are generally from the west so protection is usually required on the west side of north-south roads, on the north-west side of northeast-southwest roads, on the south-west side of northwest-southeast roads and on the north side of east-west roads.

The object of a snow fence is to mechanically reduce wind velocity near the ground in such a manner as to cause a drift to form where it will be least harmful. The reduction in velocity creates two pools of relatively calm air, a small one on the windward side and a much larger one on the leeward side, and it is here that drifts form, leaving the area further to the leeward free of drifts and comparatively free of snow. The deepest part of the calm pool is close to the windbreak; if the windbreak is open at the bottom - that is, composed of trees with few or no branches near the ground - the deepest part will move further to leeward. As winds become stronger both the depth expressed in terms of velocity reduction and the width of the pool on the leeward side will increase and the centre will tend to move further away from the windbreak.

SNOW FENCES



CROSS SECTIONS OF ROAD AND SNOW FENCES



Two methods of preventing drifts at the ends — left end of shelterbelt terminates at a hollow, right end is tapered down to the ground.

A single row of trees, unless it is a dense coniferous type, is seldom dense enough to completely stop winter wind and may create drifts, just as poor placement of windbreaks may accentuate drifting conditions.

A wide belt of trees which will accumulate a large drift of snow on its windward side may be planted right to the edge of the road, the windward edge extending back a distance equal to three or four times the height of the trees and generally at least 100 feet.

In some places the snow trap type of windbreak is effectively used. It is composed of one or more rows of trees close to the road with a wide opening to windward and then a single row of trees. The single row arrests the first force of the wind and the snow is deposited in the opening. This has the advantage of requiring fewer trees than the shelterbelt and leaving the ground between open for cultivation in summer.

Any prejudice which may exist against windbreaks for protection against drifting snow on roads arises from poor or poorly placed windbreaks. If a windbreak has openings in it or if it ends abruptly streamer drifts will form. Windbreaks should be kept dense and tapered down at the ends by using progressively smaller species of trees and shrubs to prevent the formation of streamer drifts.

Trees are being used successfully as snow fences in Ontario by the Department of Highways, by railways and by a number of counties.

The practice of the Department is to acquire the land by purchase to a width of 100 feet from the centre line of the pavement and plant a three-row windbreak 80 feet from the centre line. The land is ploughed and cultivated and bushy stock about 2 feet high is used. Weeds are kept mowed between the rows and on the open strip between the windbreak and the pavement, which entails a lot of work on the part of maintenance crews in summer. The windbreaks are kept

Highway Protected by Woodland: The protection afforded the highway by trees is well illustrated here. Note how the stretches of road sheltered by woodlots are clear of snow whereas huge drifts have formed opposite the open fields.

Poorly Placed Windbreak: This windbreak, poorly placed with respect to the highway, has created drifts across the public road.

Waterloo County Shelterbelt — Linwood: A twelve rod strip west of the road has been acquired and the six rod strip farthest from the road planted. The remainder will be planted when the original trees are larger.

Weeds must be mowed for a few years until the trees are large enough to shade them out.

down to a height of 7 feet, partly because many farmers object to their view of the highway being obstructed and also because they are proud of their herds and fields which they want to be visible to passers-by. Also cutting the tops off the trees reduces the temptation, which some persons find irresistible, to cut them for Christmas trees.

County practice varies; sometimes the land is purchased, sometimes it is leased and sometimes it is planted by agreement. In all cases the county erects a fence behind the trees. In return for the use of the land one county plants a three-row windbreak around the farm buildings. Waterloo County has planted an excellent shelterbelt over four miles long on the west side of the county road running north through Linwood. Here the county has acquired a twelve-rod strip (198 feet) and planted the six-rod strip farther from the road, leaving the six-rod strip next to the road to catch the drift while the trees are small. When the trees get bigger it is planned to complete the shelterbelt by planting the six-rod strip next to the road. The trees used are transplant stock about one foot high obtained from the Department of Lands and Forests and planted in furrows. Weeds are kept mowed until the trees are large enough to shade them out.

The species of trees used are Scotch, jack, red and white pine, white and Norway spruce and white and red cedar. The Department of Highways uses both white and red cedar, which it obtains from areas where they are growing naturally, as well as some species usually considered as ornamental stock which it grows in its nurseries. These include mugho pine, barberry and Chinese elm. This last is the only hardwood tree used in windbreaks. It grows rapidly and its fine branching system makes it nearly as effective as an evergreen tree. The other common hardwoods such as Carolina poplar, white elm, silver maple and white ash are used fairly extensively in shelterbelts.

Snow fences are usually beneficial to crops in that they hold moisture in the fields in the form of snow in winter and reduce wind velocities and moisture loss by evaporation in summer. Occasionally they do cause ice to form over crops such as fall wheat and may be harmful in this way. The beneficial effects, however, outweigh the harmful ones so considerably that every encouragement should be given to their establishment in place of the removable type of lath fence currently in use.

CHAPTER 9

WINDBREAKS

In the process of clearing land for agriculture woodlots and belts of trees along fence lines have been removed which had served as natural shelterbelts. The restoration of these in the form of windbreaks is essential to a complete conservation program in many parts of Southern Ontario. E. I. McLoughry[1] in referring to Waterloo County states:

> "Forests and windbreaks of the county have been removed to such an extent, and the organic matter removed to such a degree, that soil drifting has become a serious problem in many areas...The policy we recommend in regard to windbreaks is to encourage the planting of desirable trees."

When proper species are used and windbreaks are correctly placed the effects are almost entirely beneficial. The effects may be direct or indirect, but in either case are the result of reduction in wind velocity. The effects of windbreaks on crops and cultivated fields may be listed as follows:

(a) Direct Effects

(1) Wind damage and lodging in small grains and corn is reduced or eliminated.

(2) Snow and the resultant moisture are more evenly distributed over fields, particularly on the higher spots where they are required most.

(3) Wind erosion of the soil is minimized.

(b) Indirect Effects

(1) Moisture loss by evaporation is reduced.

(2) Temperatures in the fields are raised, which may prevent frost damage, accelerate growth and even lengthen the growing season slightly.

(3) Erosion of the soil by water may be reduced by its more even distribution when released from snow.

The benefits of windbreaks to buildings in reducing heat loss in winter have been shown to be considerable.

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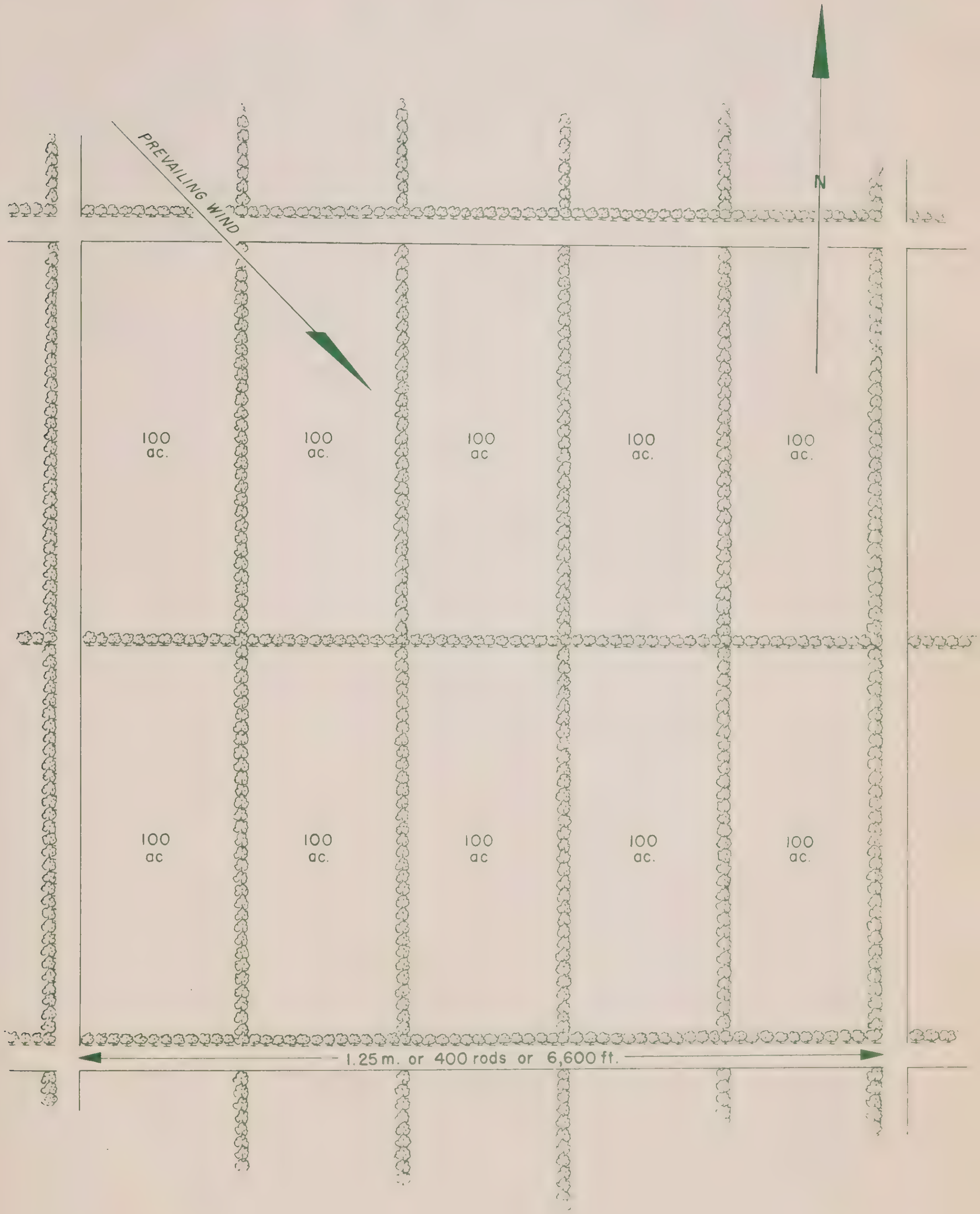
1. F.I. McLoughry. Proper Land Use Program of Waterloo County. 1950.

Experiments conducted in the United States proved that more than twice as much heat is lost from a house, per day or per hour, with a wind of 20 m.p.h. as with one of 5 m.p.h., and a windbreak can easily reduce wind velocities in this proportion. Used in this way they can often be made to form an effective background for the house and a protection for farm buildings. Another advantage of windbreaks is that they provide shelter and runways for insectivorous birds and small animals.

Belts of trees comprising one or two rows are usually called windbreaks, and with more than two rows, shelterbelts. In Southern Ontario windbreaks as a rule give sufficient protection except where wind erosion of soil on rolling land is severe, when shelterbelts may be required. On level land windbreaks may nearly always be established along existing fence lines, but on rolling land consideration should be given to the contour of the land. The prevailing winds in Southern Ontario are generally from the west, so that the greatest protection will be derived from windbreaks on the west side, but the placement of windbreaks on the other three sides as well should be considered.

Both the height of the trees and the wind velocity influence the effective range of a windbreak. An average windbreak will reduce the ground velocity of a 20-mile wind 10 per cent or more for a distance of about 30 times the height of the trees. About one-fourth of this effect will be felt on the windward side of the windbreak and three-fourths on the leeward side. For example, if the trees are 40 feet high the total effective range with a 20-mile wind will be 30 x 40 or 1,200 feet, 300 feet of which will be on the windward side and 900 feet on the leeward side. Generally speaking, the reduction in velocity is greatest close to the windbreak and tapers out to zero further away. With higher wind velocities and/or higher trees the proportionate reduction and the effective range will be greater.

WINDBREAK PLAN
for
1,000 ACRE BLOCK



This plan shows the minimum windbreak requirements for a 1,000 acre block on level land. Woodlots and plantations will replace some of this and placement will have to be adjusted according to topography and soil on rolling land.

A windbreak not only reduces the velocity of wind striking it but also slightly increases the velocity of the wind diverted over, round or through it if there are gaps. The increase in velocity of winds passing over it increases its effectiveness somewhat but the increase in velocity of winds passing round or through it will increase the damage caused. For example, snow drifts will form at these points (see chapter on Snow Fences).

On level land in Southern Ontario windbreaks completely surrounding each farm of 100 acres would normally give adequate protection except for light rolling land and such wind-sensitive crops as tobacco. These should be on the west side of north-south roads, but on east-west roads would have to be carefully placed on the north or south sides, depending on the direction of the local prevailing winds. On land which is not level at least the same proportion of windbreak to area should be provided, but in many cases this would have to be adjusted according to the local topography. That is, the trees should be planted on suitable contours and where hilltops or slopes are eroding badly it will be necessary to establish plantations over a large part of the eroding area. The windbreaks should, of course, be tied in with plantations and existing woodland so that where these exist additional protection would not be required.

Since density, both in winter and summer, is one of the prime requisites of a good windbreak, the conifers in most instances make the best windbreaks. The slower-growing species such as white cedar and spruce give most protection, but the faster-growing ones such as the pines have the advantage of attaining more effective heights in a shorter time. A number of broad-leaved trees have fine, dense branching habits and may be nearly as effective as conifers if the branches are maintained down to the ground; among these may be included sugar maple, Chinese elm and European alder.

A windbreak which has effectively eliminated wind erosion on light land.

Crop shows little loss in size or vigour when planted close to European alder.

This is not the prairie but a windswept, treeless stretch of Perth County.

Contrast this farm home with the house above. The windbreak gives protection, comfort and stability.

European alder is gaining great popularity as a windbreak tree because it is a nitrogen-fixer like the legumes and does not rob the soil to the same extent as non-nitrogen-fixing species. In fact, tobacco is frequently planted close to it with little loss in size or vigour of the plants. As the robbing of the soil is one of the severest criticisms levelled against windbreaks, consideration should also be given to the planting of such leguminous trees as honey locust and caragana on certain sites.

One consideration that should be kept in mind is that under certain circumstances windbreaks may cause air stagnation, which may increase temperature and moisture conditions to a dangerous degree in summer or increase frost damage in spring and fall on small areas, particularly in hollows. Where this is likely to occur, windbreaks should be planted so as to guide the flow of air past such spots. Where these conditions develop after the windbreaks are established they may be relieved by judicious opening up of the windbreaks.

Experience has shown that windbreaks are an asset to any farm, that their adverse effects, if any, are local and easily remedied, and that in many areas they are essential to the control of soil erosion by wind. It is therefore recommended that the Authority encourage the establishment of windbreaks by private owners in every way.

CHAPTER 10

SAWMILLS AND WOOD-USING INDUSTRIES

For many years the forests which originally covered most of Southern Ontario were a hindrance to the progress of agriculture. The forest was burned and slashed to clear the land for crops and, with only a small portion of the timber cut being utilized, the realization from this measure was small. Later the manufacture of lumber and other forest products became an important industry. Exploitation of the forest capital rather than harvest of a crop became the prime motive. This sequence of attack on the forest brought about rapid depletion of the virgin timber.

The dwindling forest resources suffered further as available merchantable timber was liquidated from time to time to bolster set-backs in agriculture. In time of need the farmer derived income through woodland sale.

This process of woodland depletion went on without consideration of forestry as an integral part of the farm business. Yet perhaps the most promising means of supplementing farm income to maintain a satisfactory level of living in many rural communities is the husbanding of the forest resources and the development of a permanent woodland enterprise. Many farmers strive for high yield per acre or per animal in agricultural enterprises, but few extend comparable attention to the productivity of their woodland.

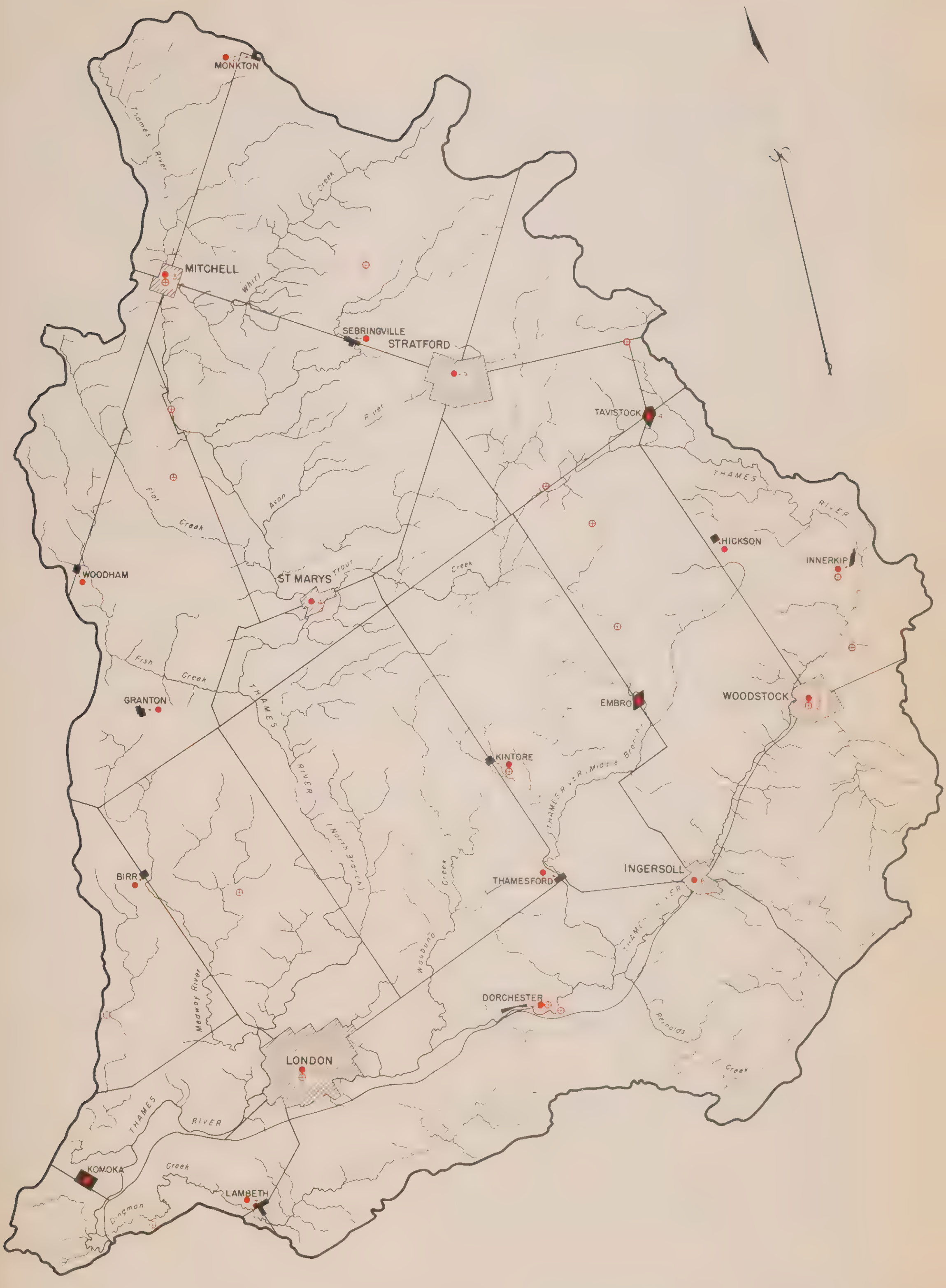
As forest depletion became more acute there was a rapid decline in forest industries. Now the forest plays only a minor part in rural economy in Southern Ontario. Satisfactory processing facilities are no longer available in many sections to provide adequate outlets for farm forest products.

When the farm woodlot is managed according to good forestry practices and the wood growth of a given area

removed annually or periodically in trees of appropriate size, instead of treating the entire woodlot as a crop and more or less clear-cutting once in a minimum of sixty to eighty years, then the woodlot should provide in the majority of cases a periodic cash return to the farmer from log and fuelwood sale. This selective logging then, involving annual cutting equivalent to the annual increase in volume, offers to the log market small numbers of logs of different species and all grades from the individual farm woodlot, with greater numbers of logs from the larger woodlots.

The profitableness of the woodland enterprise depends on the availability of adequate marketing facilities. The primary users of woodland products such as sawmills, veneer mills and others are not the only markets but all the industry that depends on the primary plants for its raw product, whether purchased directly from the plants or through the intermediate handlers or processors. Thus a study of the farm woodlot marketing problem should follow the woodland product from the tree on the stump through to its ultimate consumption, whether in the manufacture of furniture, wooden heels, veneer or plywood, farm implements or any of the many other products of the wood-using industries including lumber for construction. For this reason a study was made of the present log market in the Thames Watershed to determine how it functions, the outlets for its products and the sources of wood for the local wood-using industries.

In this report the term "hardwood" is used to denote all broad-leaved trees irrespective of whether the wood is physically hard or not. This practice is followed by large firms which handle both hardwoods and softwoods. At the smaller sawmills and lumberyards and among farmers it is a common technical misnomer to term as softwoods the hardwoods which have physically soft wood such as poplar, basswood, white (swamp or soft) elm, willow, and sometimes soft (red and silver) maple. For example, a sawmill with stove-length slabs for



SAWMILLS
AND
WOOD-USING INDUSTRIES

LEGEND

● WOOD-WORKING PLANTS AND LUMBER YARDS (79 ESTABLISHMENTS)

⊕ SAWMILLS (19 MILLS)

(● – 2 Figure after symbol indicates number of establishments)

SCALE MILES
1 0 1 2 3 4 5

fuelwood offers -

softwood - white pine, white elm, hemlock, basswood and poplar
at $11 per standard cord delivered

hardwood - white ash, beech, cherry, oak and the maples
at $15 per standard cord delivered.

In the above case three broad-leaved species which have wood of soft texture are termed "softwood".

Since the forest growth and logging industry in the area are dominantly hardwood, the discussion throughout this chapter is relative chiefly to hardwoods.

1. Local Wood-Using Industries

The sale of sawlog material from the woodlot depends on the mill-operator having sale for the lumber he manufactures. The following study of local wood-using industries shows their dependence on supply from local woodlands.

There are no natural boundaries in the field of manufacturing from wood at which divisions can be made for study. In this report the industries whose products are ordinarily thought of as being made of wood are termed the wood-using industries. Because of this limitation some manufacturing establishments which consume large quantities of wood were not visited.

In the area 79 establishments qualified as wood-using industries or intermediate handlers of lumber products. These have been separated into three general divisions as follows:

(a) Lumber merchandising, millworking, and allied field;
(b) Miscellaneous general woodworking;
(c) Manufacturing specific wood products.

Some overlapping between the three groups seems unavoidable. The phases of the lumber and products industry encountered and the sources of their raw products are outlined.

Selective logging. The 21-inch maple in the foreground is blazed for removal while the 16-inch maple in the background has been left. At the smaller size hard maple is putting on its "quality growth".

Some operators do not pay their Grade 1 prices for logs with centre defect, while others do. Maple syrup spiles caused the small dark marks seen on this butt log.

(a) Lumber Merchandising, Millworking, and Allied Field

Each of the 44 establishments in this group belongs in either or both of the following general categories:

(1) Lumberyards - retail and wholesale - may do millworking to varying degrees; some have an associated construction business; most handle the general builders' supplies.

(2) Millworking plants - primarily planing, matching and moulding; may be purely custom or may manufacture and stock their products.

Lumberyards market chiefly to the construction field; thus their turnover is mainly softwoods (generally over 90 per cent). Over nine-tenths of the hardwood handled is flooring and is oak (imported), yellow and white birch and hard maple with lesser quantities of beech, elm and white ash. Over 95 per cent of general yard stock is "imported" from Northern Ontario, Quebec and British Columbia - and lesser quantities from the Prairie Provinces and the Maritimes. The outside points which supply the local lumber merchandisers with softwoods in many cases offer well-graded hardwood lumber too. Thus the local hardwood sawmilling industry must compete against the goodwill established by salesmen from these outside points. The yearly volume handled by the lumber merchants in the Thames area varies from about 100,000 board feet by the smallest dealer to over 6 million board feet by the largest. A small percentage of this field of business backs sawmilling financially or owns mills outright in the softwood areas of Quebec and Ontario. A few of the lumberyards may act as wholesale sources for industries using hardwood lumber, especially the furniture industry. Purchasing their supply from local and more distant or regional sawmills they may maintain a considerable stock on hand or carry on a brokerage type of business.

Millworking establishments manufacture large quantities of softwoods, which are chiefly "imported", into sash, door, interior trim, frame, all types of siding, and other products including relatively small quantities of flooring.

Some damage in felling is inevitable even when the logging is done by expert cutters.

Log skidding to roadside for truck haul. This professional teamster and team were brought by truck more than 60 miles to do this skidding.

The chief species used are eastern and western pine, spruce, and hemlock; western cedar and Douglas fir. Lesser quantities of local or imported hardwoods are used for stair-treads and risers, door sills, interior trim, and similar products. Included in this group are establishments making small pre-fabricated buildings such as cottages, garages and small homes.

(b) <u>Miscellaneous General Woodworking</u>

The 13 establishments placed in this category are typified by the extensive variety of products made by each enterprise, and by the fact that in general they are small consumption units, using less than 30,000 board feet of lumber in a year. They do custom work chiefly, but in some cases certain products may be stocked in quantity. The variety of products made is shown by the following partial listing: kitchen cupboards and cabinets, store counters and showcases, book-shelves and wall brackets, magazine stands, wooden toys and children's commodes, washboards and clothes-horses, lawn furniture, lawn-mower rollers, wagon boxes and tongues and other general farm equipment and repairs, chicken crates, various types of ladders, machinery crating, wheelbarrow handles, dowels, and patterns. The hardwoods and softwoods used in these manufactures are chiefly local and are obtained from local lumber merchants or direct from local sawmills. In some cases 4-foot bolts of yellow birch are brought in direct to a plant, or local logs may be bought and sawn at nearby mills. Included in this miscellaneous category is an enterprise engaged in salvaging lumber from demolitions, fires and so on. Where possible this is made into 2 x 4's, fence pickets and other small stock.

(c) <u>Manufacturing Specific Wood Products</u>

The 22 establishments in this group represent 10 different types of manufacturing:

Farmers often do very little of the woods work. This lump sum purchase bought only the logs that could be made. The farmer paid the buyer's cutting crew to make the tops and limbs into 4-foot fuelwood.

Poor piling of random lengths. The grade of lumber is often lowered during seasoning due to poor piling practices which encourage warping.

Product Manufactured	No. of Plants	Raw Material and Source
Rowboats and small power boats	1	Softwood and hardwood lumber - local, regional and "imported"
Box shooks, boxes, crates, and cheese boxes	2	Softwood lumber - imported Hardwood logs and lumber - local
Slack and tight cooperage	2	Hardwood staves - American and "imported" Hardwood stave bolts - local
Caskets	2	Hardwood and softwood lumber - "imported" and regional - American "woods of value"
Furniture	6	Hardwood and softwood lumber, plywood - "imported", regional and American
Musical instruments	2	Hardwood and softwood lumber - American and local
Sporting and playground	3	Hardwood lumber - local and American
Milk-bottle cases, dairy equipment, farm implement parts	2	Hardwood and softwood lumber - "imported", local and American
Veneer	2	Hardwood logs - "imported", American and local

This group consumes chiefly hardwoods, a considerable volume of which is local supply. Four of these plants rely partly or completely on a supply of raw logs to carry on their manufacturing. These are:

Kintore Boxes, Ltd., Kintore - purchasing local white elm, ash, basswood and beech for the manufacture of cheese boxes and box stock; operating a small veneer mill.

London and Petrolia Barrel Co., London - although most of the material required by this plant comes as rough staves and headings from its own mills in Tennessee, a considerable quantity of white oak and lesser quantities of beech, maple, ash, cherry and red oak are purchased locally for the manufacture of tight cooperage.

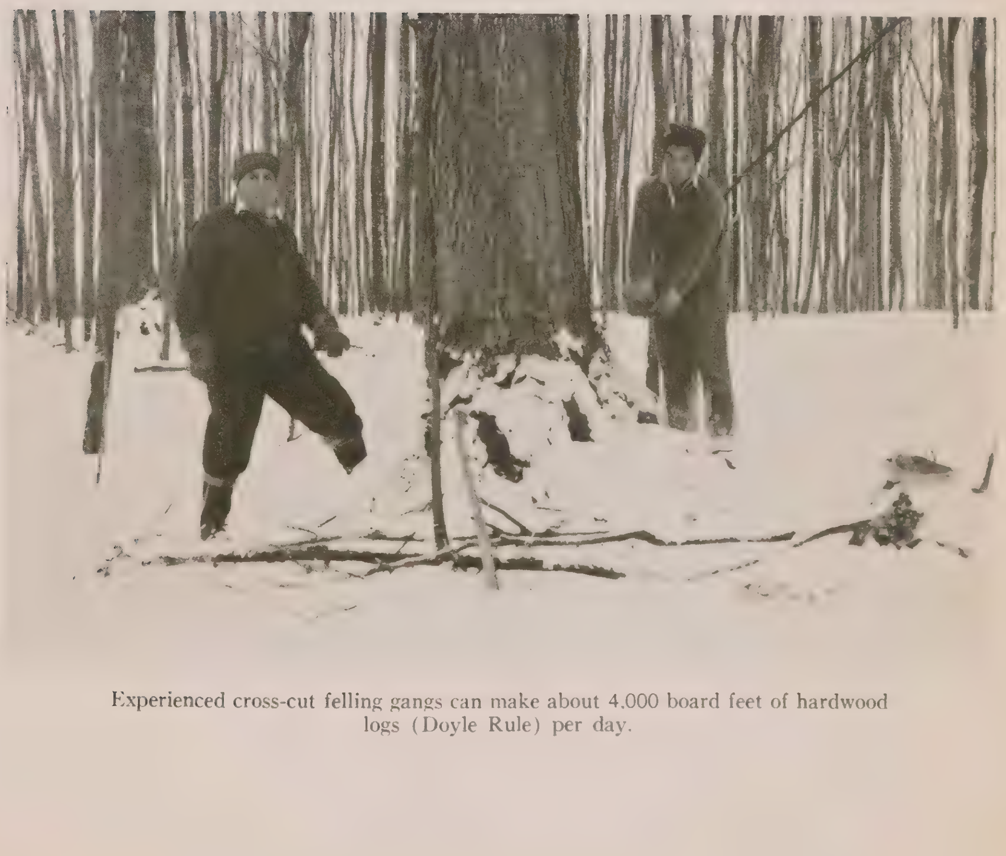
Wood Mosaic, Limited, Woodstock - specializing in the manufacture of face[1] veneers and oak flooring requires that this plant import a large part of its stock from the United States. The veneer logs used are chiefly birch and walnut with lesser quantities of oak, hard maple, walnut, mahogany, and others. Where possible logs are purchased locally but quality, quantity and species are limited. The flooring is manufactured from rough lumber and is chiefly imported red and white oak with smaller volumes of regional or "imported" birch, hard maple and beech.

United States Plywood Corporation (Canadian subsidiary), Woodstock - producing large quantities of crossbanding[2] veneers, manufacturing furniture corestock, plywood and various products with plywood cores makes the raw material source of this plant chiefly Canadian. Yellow birch, oak, hard maple, basswood and elm are consumed in large quantities. Where possible logs are purchased locally but quality, quantity and species are limited. Softwood is used for cores in the manufacture of some products such as doors made on the plywood principle.

The last two establishments in this group use several million board feet of logs for veneer and several million feet of lumber for flooring, plywood cores and other uses.

1,2. The centre portion of a plywood panel is the core. It may be a veneer core or a lumber core. The veneer core is simply several plies of veneer. The lumber core is made by gluing strips of wood together and, depending on the width of these strips, the final product has various trade names such as blockboard and battenboard. The lumber core is then covered, on top and bottom, by a sheet of veneer to "band" the lumber strips together. This is termed "crossbanding veneer" since its grain lies crosswise to that of the next outer ply and that of the lumber core. Depending on the use to which the plywood is to be put, whether of veneer or lumber core construction, it may then be "faced" with a fancy "face veneer" such as mahogany or walnut and "backed" with a less expensive "back veneer" such as elm or low-grade birch.

Professional power saw loggers can make up to 10,000 board feet of hardwood logs (Doyle Rule) per day. The high cost of the power saw is beyond the majority of farmers.



Experienced cross-cut felling gangs can make about 4,000 board feet of hardwood logs (Doyle Rule) per day.

Lack of efficient grading is a shortcoming of the local sawmilling industry. Generally industries manufacturing from wood are quite exacting in their demands for specific lumber grades. They are, to a large degree, prepared to buy locally and avoid freight rates if there is assurance of well-graded lumber in continuous supply. But, when a mill of relatively small annual production carries out grading, the various grades become separated into rather small volumes; this necessitates considerable "shopping" by a consumer in order to obtain a good quantity of a given grade of a certain species. Inefficient grading and sporadic supply discriminate against the regional lumber manufacturers; however, the consumer may reduce the grade risk in such purchases by a personal visit to the mill when it is located nearby. The establishment of mutual goodwill between the small lumber manufacturers in Southern Ontario and the wholesale consumers, rather than reliance on rigid grading, is a major factor in consumer purchasing. Often the mill owners allow the purchasers to sort their mixed grade piles and accept the grades assigned without question.

2. Sawmilling in the Area

Nineteen sawmills were in operation in the Upper Thames Watershed at the time of the survey. On the basis of figures supplied by their operators the 19 mills annually produce about $2\frac{1}{2}$ million board feet of lumber. Of this almost half is custom sawing and the remainder is termed "other sawing".

The $2\frac{1}{2}$ million board feet is the approximate quantity annually produced by the 19 mills; it does not represent the annual volume of logging within the Thames Watershed. The reasons for this are obvious. Logs are hauled to some of these mills from points outside the survey area; trucks haul logs out of the area to other sawmills, veneer mills etc.; portable mills move freely into the area to carry

on operations, although only one was encountered during the survey; and fields of utilization other than sawmills process or use rough logs, for example, piling for construction of bridges, and stave bolts for cooperage.

An example of extreme distance that logs from the Thames area are transported for special purposes is illustrated by the statements of a timber exporter who obtains part of his supply from the Thames area. This exporter currently ships about a million board feet (log scale) annually and during the war years shipped about two million feet annually. A large percentage of this is shipped to overseas shipbuilding yards, chiefly to the British Navy. Rock elm, white elm and hard maple are the chief species handled by this exporter, who maintains a field buying staff and several cutting crews. The logs are obtained from a large general area in Southern Ontario from Windsor to Barrie to Ottawa. Rock elm has highly valued qualities which put it in special demand for the construction of lifeboats. Most of the material shipped overseas is in log form but a small quantity of hard maple shipped to Quebec shipbuilding yards may be squared.

There are no growth rate, yield or inventory data for Southern Ontario woodlots. It would be useful to determine whether the current annual cutting rate on all private lands or in a specific area is in excess of annual growth. Logging operators state that sawlog yield from hardwood stands in the general region of the survey is generally between 6,000 and 11,000 board feet (log scale Doyle Rule) per acre (or 15 to 30 cords of fuelwood). This yield is from stands of trees of mixed age from immature to overmature. On the basis of this general statement the annual cut of the 19 mills is approximately the yield from 300 acres of unmanaged woodland.

3. Reasons for Frequency of Small Sawmills

Formerly many portable mills operated by professional lumbermen operated in the general area. These followed the movement of the main body of the lumber industry as it moved in quest of virgin timber. Many scattered areas of good timber were left behind by the first operators. Also there had been rapid regrowth of forests in the cut-over areas, chiefly as a result of accelerated growth in areas which had been high-graded. These factors, coupled with continued land-clearing operations for agriculture stimulated by employment of artificial drainage, provided a natural field for small portable mills. After a time, as the acreage of standing timber was reduced, the logging opportunities became less. Some of the early permanent mills were dismantled and moved to more wooded areas, or were allowed to fall into disrepair and were finally abandoned. The numbers and annual cut of portable mills became less.

To move a portable mill the operator has to be assured of a minimum footage of timber to saw in order to pay the costs of moving and setting up the mill at a new logging site and to provide a measure of profit. It gradually became more profitable to move the logs to the mill than the mill to the forest. Present conditions of improved roads and efficient logging trucks have tended to put the portable mill on a permanent location. Now, larger mills may haul logs 75 miles and more, and high-grade logs for special purposes such as veneer may be hauled almost twice this distance.

The condition of more stationary location of mills rather than numerous portable mills reduces the threat to woodlots. The portable mills requiring a minimum footage for their operation often engaged in clear-cutting practices in the small woodlots. Modern motor transport of logs is very flexible and can be more readily directed to favour woodlot improvement by selective logging.

Many of the mills in the Thames Watershed are farmer-operated and their annual productions are very small. Some reasons for the establishment of small production mills, chiefly the farmer-operated type but also lumberman-operated are summarized as follows:

(a) Minor capital outlay

Availability and cheapness of mills. Old secondhand portable mills are readily available. Some mills are rebuilt from old mills abandoned in junk heaps. Manufacturers offer new portable mills at relatively low prices.

(b) Suitability of small mills to the present situation

The conditions referred to are those of sporadic and light supply to the mill due to the scattered nature of the small tracts of second-growth timber and also due to the attitude of woodlot owners to logging their woodlots. This attitude varies from complete apathy through all stages of mismanagement to, in some cases, a good attempt to practise the commonsense principles of sustained yield.

(c) Availability of power for mills

The commonplace, versatile farm tractor provides power. Since in most cases it is already a piece of the farm equipment, there need be no initial outlay for a power unit, as was the case when mills were powered by expensive portable steam units which had high maintenance and labour-operating cost and also created an extreme fire hazard. Another ready power source now is by conversion of old truck and car motors to sawmilling service. About 65 per cent of the 19 mills in the area are powered by internal-combustion engines and 80 percent of these are tractor-type power units.

(d) Farmer and other local needs for lumber and timber

Farm building and equipment repair and the occasional new building provide seasonal and emergency sawing for a small mill working chiefly on a custom basis. Since the mill does not have to provide against high overhead or expensive labour nor retire a large capital outlay, the

probability of very extended periods of idleness is of little consequence to its owner; in fact it is generally planned that these fit in with other seasonal work.

(e) Lumber Prices

Attractive lumber prices start many small mills. (Business depressions put many out of business.)

4. Mill Output - Daily, Annual and Custom

Daily output varies among the mills from 1,500 to 5,000 board feet, with the daily sawing rate for the majority of mills being 2,000 or 3,000 board feet. Only a few of the mills are operated on a professional basis. The daily output of a small mill varies almost directly as the number of men working and so can be increased - up to a point - by increasing the number employed. The output per man per day is about 1,000 board feet, with a predominance of hardwoods lowering this figure somewhat. Mills operated by non-professional owners may operate only a few days or a few weeks in a year. Thus annual production figures are of more significance than daily output figures. In the following table the mills are arranged in order of increasing annual output; the percentage custom sawing of annual output is shown.

The mill of largest output saws a little less than 3/4 million board feet annually. The total output of the 19 mills is 2,420,000 board feet, the mills averaging about 130,000 board feet annually, and 69 per cent of the mills produce less than this average.

About 45 per cent of all the production is custom work; in general as the annual output is greater the custom per cent is less. The 13 mills sawing annually 75,000 board feet or less spend more than 70 per cent of the time on custom logs and do about 36 per cent of the total custom work in the area. Mills sawing annually more than 75,000 board feet spend about 35 per cent of the time on custom logs; these

Mill No.	Annual Output (Board Feet)	Custom Per Cent of Total Annual Output
1	20,000	100
2	30,000	100
3	30,000	50
4	30,000	70
5	30,000	95
6	35,000	80
7	40,000	95
8	40,000	90
9	50,000	100
10	50,000	5
11	50,000	75
12	65,000	100
13	75,000	20
Total of Mills 1-13	545,000	71
14	150,000	0 (own manufacturing business)
15	175,000	95
16	250,000	5
17	300,000	20
18	300,000	10
19	700,000	60
Total of Mills 14-19	1,875,000	37
Total of All Mills	2,420,000	44

mills do more than 75 per cent of all the sawing in the area. The 3 largest mills do a little more than half of all the sawing and almost 40 per cent of their output is custom.

For custom sawing the general practice is to charge at a set rate per 1,000 board feet mill run - the rate being common to all species. Some mills vary this by adjusting the price according to the general size of material to be sawn out. This adjustment shows a tendency toward hourly rate sawing because by it there is a higher charge for sawing out stock of smaller thicknesses. This is to compensate for the extra time required for the greater number of cuts or "runs" of the saw in making smaller thicknesses in contrast to making larger stock such as planking. Occasionally the charge for cutting out extra large stock or timber is levied by the running or lineal foot of timber and the rate is different according to the length of the timber. Unless otherwise understood, the slabs and waste which accrue from the sawing belong to the mill operator.

The other basic method of charging for custom sawing is employment of a straight hourly rate covering the time of log handling in the yard, sawing, piling, and mill stoppage due to staples, tapping spiles, wire or other metal pieces embedded in the logs. The danger of a saw striking embedded metal pieces in logs is a very important factor limiting use of the more efficient band saw in Southern Ontario even by the largest mills operating on a strictly professional basis.

Most of the mills visited are distinctly the non-professional type. They are operated by farmers and do chiefly custom work, supplying the local need for this type of service. As a group they are extremely inefficient mechanically and from a wood-utilization point of view. Owners of these mills state that custom sawmilling is not profitable and the mills are operated only as a service to the community and a convenience for their own lumber needs.

Larger professional-type mills definitely discourage custom work. Some may do none, while others may reluctantly saw only for those who occasionally sell them logs or for certain selected customers in order to maintain, for various reasons, a certain amount of goodwill. This attitude has considerable justification. Often the charge levied pays only for the direct labour involved and other overhead must be absorbed by the mill owner. This situation arises from the extra labour involved in trying to saw from a given log the sizes of product specified by the customer and in the extra handling involved in keeping the individual's lumber apart from that of other customers or of the mill owner. Often, too, normal mill routine may be considerably interrupted by a "custom job".

When a woodlot owner needs a quantity of lumber for a new building or general repairs about the farm, he takes whatever logs he can to the mill. Often the value of the species and of the grades that could be sawn from the logs is far above that warranted by the use to which the material is put. He would be well advised to take credit for his logs and let the mill operator supply him with species and grades best suited to his requirement. The mill operator should supply these at preferred prices, since often he would profit by being able to dispose of his poor grades of low market value which he has on hand and in return receive a quantity of better grade material which can be diverted to more economical use. It is not uncommon that owners of small mills barter sawing or other services for logs.

5. Log Transportation and Source Distance

Truck hauling far exceeds any other method of log transportation; much of this is by special logging trucks. The improvement of log transportation by truck over improved roads has put the portable mill on a basis of permanent location; it could aid farm woodlot management on a large

scale. The motor truck can be utilized to provide great latitude and flexibility in picking up logs in the open market from skids located along improved roads.

The smaller sawmills which do chiefly custom work serve comparatively small areas, generally less than a radius of 10 miles - farmers wishing custom work generally go to the nearest mill. The larger mills operated on a professional or semi-professional basis go much farther afield for their logs. Some of these mills may rely on sufficient supply being delivered to their yards independent of field representatives making contacts with farmers; but more often, to obtain satisfactory supply at suitable prices, field representatives are used to purchase or encourage the making of logs or to buy standing timber. These purchases may be made 75 miles or more from the mill by a few of the mills, but a general operating distance is 20 to 40 miles. High quality logs for special purposes such as veneer manufacture may be hauled much greater distances than logs for sawmilling.

6. Log Purchase Methods

There are two distinct sources of raw material from the viewpoint of the sawmill operator. These are (1) timberland, owned outright by the operator or on which he has cutting rights by contract, and (2) open log-market purchases. However, it is rather common for the mill owner to purchase a few selected standing trees in a woodlot at a stumpage rate or an outright lump sum, or offer a delivered-in-the-yard rate for the logs.

The majority of mills visited obtain raw material chiefly by purchase in the open market. The logs are bought in skids or delivered in the yard with a fair price differential to cover hauling costs. A few mill operators derive sufficient supply from the woodlots on their own farms. In general, only the largest mills practise buying entire woodlots for logging. Often these owners buy whole farms in

order to acquire the woodlot, then resell while retaining cutting rights in the woodlot for a given number of years. Some mill owners purchase woodlots on an acreage basis; one operator reported paying about $100 per acre for swamp woodland - chiefly hardwoods.

The method of purchase of entire woodlots generally involves an estimate by the prospective buyer according to his own methods of the probable output of the stand. He then offers payment on this basis on whatever terms are agreeable to both parties. Agreements are widely variable; "deals" are made in any way possible. Undoubtedly many of these "deals" are designed to take full advantage of the present income tax law which treats revenue from selective logging as income and therefore taxable, while clear-cutting revenues constitute capital gain and therefore are not taxable. Unfortunately, as long as the tax law has its present interpretation the vicious practice of clear-cutting instead of increment cropping is favoured.

The availability of woodlots for purchase is a matter of prime interest. According to mill owners whose families have long been operators in the region, woodlots become available chiefly when a farm changes hands due to retirement or death of the owner and when there is no immediate family who will carry on the farm. Often these farms are put up for sale by auction, and when such a farm has a reasonable area of bush, it is common practice for timber operators or their agents to submit bids. Apparently the parties making such sales are often absolutely ignorant of the cash value of the woodland. Frequently log buyers are able to purchase these lands at ridiculously low prices and in the long run acquire the entire merchantable yield of the woodland at an extremely low cost per thousand. Generally in these acquisitions the farm is re-offered for sale but cutting rights are retained. If re-sale is not immediate, the farm may be rented

as pasture or in favour of the best opportunities offered. Professional mills of comparatively low annual output may be satisfied with only one such purchase a year, whereas larger mills may make several. Sometimes such areas of woodland may be held as a reserve supply against times when other supply or quality may be short. Purchases of this type may influence the interest of the timber operator in relatively small quantities of farmer-made logs and also the price offered. Local municipal officers, especially township clerks, are generally aware of properties being offered for sale by auction. It is therefore recommended, when woodland is involved, that they remind the title-holder to obtain advice from the Zone Forester on having the woodland value appraised by competent personnel prior to the sale.

Many counties now have diameter limit by-laws to control cutting for sale. These are designed to stop the practice of clear-cutting or slashing woodland. In the clear-cutting operation everything that can be made into a salable product is removed from the woodland; this is definitely not according to good forestry practices. The natural process in such devastated areas, augmented by the negligence of the owner in pasturing, leads to the establishment of small woody shrubs such as raspberry and dogwood. The land is lost to any economical use for many decades. It is wasteland.

In counties where diameter limit by-laws have been enacted the practice of clear-cutting is reduced to cutting everything salable to the legal diameter limit. This again is not good forestry; however, it is preferable to absolute clear-cutting.

The woodlot owner may sell his sawlog material in one of three basic ways - lump sum method, at a price per thousand feet on the stump, or made into logs. Experienced log buyers can appraise the volume in a timber stand quite readily, and some can do it quite accurately. Some buyers

estimate the volume in only a percentage of the trees in a stand, whereas buyers who really know their work tabulate the species and merchantable volume of each tree and keep some record of the probable grade outturn. One operator, located outside the watershed but purchasing a considerable volume within the Thames area, takes pride in his ability as an estimator; he tabulates every merchantable tree in a woodlot. Actual records of woodlot estimates compared with actual log volumes received at the mill from the individual areas show that his estimate is consistently within 6 per cent of the measured log run. Some years ago in competitive bidding for 87 acres of woodland by the lump sum method he estimated the stand to be 700,000 board feet; the chief log-buyer for a large furniture manufacturer estimated 350,000 board feet; another log-buyer estimated 100,000 board feet. The log volume cut from the stand was 746,000 board feet. This illustrates the great spread possible in volume estimating of hardwoods even among those whose business is the buying of timber on the stump. Many years of experience taught this buyer that in the long run in making purchases it is cheaper to estimate the volume in each tree rather than in a percentage of the stand.

(a) Lump Sum Transactions

The method of lump sum purchase is used to buy entire woodlots, all or certain species to a stated diameter limit or trees selected by the owner or the buyer. A lump sum purchase is based on a volume estimated by the buyer. In the case just cited each prospective buyer intended to use the bush for the same purpose, the manufactured product was intended for the same market, and so it is safe to assume that each put approximately the same basic value into his calculations for the lump sum bid. Obviously, under these conditions the sum offered by the buyer using the highest volume estimate would be the most attractive to the woodland owner. The buyer's risk

in this purchase is reasonably secure because the basic price per thousand board feet that he uses is totally influenced by all the conditions and risks that experience has taught him to appraise in each purchase. The basic price represents what the timber is worth to him standing. Thus in any lump sum purchase in an area where there is keen competition by log-buyers the old law of supply and demand should bring the owner the best price for his timber that the market will pay. It is essential though that competitive bids be sought, and from as many log buyers as possible. These buyers should represent all the fields of manufacturing from logs whose establishments are within economical operating distance of the woodlot. Standing timber is bought by scores of forest product enterprises; some of these are sawmills, furniture plants, basket plants, shoe-last block plants, cheese box plants, brush block and handle plants, timber operators who get out rough pile or post or pulpwood products; or by middlemen who operate woodlands for sale to these enterprises. The seller is advised to consult the lists of buyers of woodland products held by the Department of Lands and Forests at its Zone offices.

Many of the larger timber operators prefer to purchase their requirements by the lump sum method. The most competent buyers can successfully offer winning tenders and leave themselves the necessary safety margin to take care of the logging chance. Realization on a venture is greater according to the buyer's ability to carry through the operations on a better cost sale ratio than was used in the calculations setting his lump sum bid. The buyer accepts this challenge to his abilities and in the long run hopes that the chance taken proves profitable. It is not always so. Buying logs in skids or delivered to the mill removes the financial risk in lump sum stumpage buying; it also removes the chance for the extra margin of profit which is a measure of his ability as a stumpage buyer and logger.

(b) Stumpage Rate Transactions

Selling at so much per thousand board feet puts the sale on a volume basis - volume removed is the payment basis - or what some millmen describe as an arguing basis. The buyer may have agreed to cut the entire woodlot or all or certain species to a diameter limit or only selected trees. In any case the buyer has to measure the volume removed. In some cases the purchase agreement is a straight price per thousand board feet, but generally the buyer puts each log in one of two or three grades. The price schedule for the different grades might show the best type of log to be worth almost three times as much as the poorest grade of log, although the actual volume in the two logs is the same. (More is said about log grades in the following section on Stumpage Rates - Log Purchase Prices - Log Grades.) The woodlot owner does not know the business of manufacturing from logs and quite often feels he should dispute the log grader's allocation of certain logs to the low price category. Another strong reason for buyers wishing to purchase by the lump sum method is to avoid these arguments and the bad feelings which may result; often too such an owner puts the reputation of the buyer in a doubtful light prejudicial to the buyer's future business in the area.

Some buyers will purchase only by the lump sum method but most will purchase by either the lump sum or volume removed basis. The woodlot owner must decide whether he would do better to take the lump sum offered and leave the risk of log grade and volume recovered with the buyer or sell at so much per thousand and accept the risk of the grade of the material that will be removed. What the buyer intends to cut and pay for should be absolutely clear to both parties. He might remove only the best trees and possibly only take the best logs of these trees. This leaves the owner with many poor quality logs that he cannot readily sell, with some poor trees standing that he wanted cut, and the volume actually

paid for might be small. His total realization on the transaction might be less than by the lump sum sale method.

Whether the sale is by the lump sum method or on a per thousand basis, a written Timber Sales Contract should cover the transaction. It should set forth all the details necessary as to prices, species, sizes, rights granted to the buyer, limiting dates, times of payment, and so on. There may be considerable differences between contracts depending on method of buying, standards of measurement, type of material involved, etc. It pays to deal with established, reputable firms or buyers in the sale of woodland products. In many cases logs are transported 75 miles or more to a place of manufacture, or the owner is not resident near his woodland - it is in the interest of both parties to set forth their agreement in a written contract.

(c) Owner Log-Making

The woodlot owner may consider that he can realize labour income from sale of his timber if he sells it already made into logs and placed in a skid at the roadway, or delivered to the mill. Currently sawmills in the area pay about $20 per thousand more for logs delivered to the mill than is paid for standing timber. However, sawmill men say they would starve if they had to depend on the volume of owner-cut logs as the only source for their sawlog needs.

The majority of small owners do not log their own woodland. Some buyers would rather buy their requirement already made into logs but often cannot persuade the owner to take advantage of potential returns from the woodlot harvest by doing his own woods work. The reasons for this are not too evident. It first must be agreed that woods work with heavy hardwood timber is dangerous to the inexperienced. Many farmers can tell of members or friends of their families who were maimed or killed in earlier days in woods operations.

The average owner has not had much opportunity for experience; unless a woodlot is managed according to selective logging principles the opportunity for experience is not continual. Too many owners take absolutely no interest in their woodland - do not even take out fuelwood and instead buy coal or oil.

In an age of specialization experts in their fields and production line techniques set the price for the finished product or unit of work. Professional loggers set the price for felling, log-making, skidding and hauling. Their skills and production rates come from continuous experience. Realization for the various logging phases is most often paid by the buyer on a piece-work or volume produced basis. Whereas by the piece-work rate the skilled operator might be well paid on a day rate basis, the unskilled farmer might be poorly paid, have actually worked harder but much of the labour was wasted, and at the same time a poorer product resulted and considerably more damage was done the woodlot than by the skilled operator. At the end of the operation the amateur logger is probably much wiser, but most likely the profit is educational and not financial.

The needs of the buyers as to length and quality of logs vary from buyer to buyer, and time to time in the case of one buyer. Often a premium is paid for the product for which the buyer has great need. The quality of the log made rests largely with the log-maker by his choice of log length and thus the location of defects in the individual log. Proper appreciation of the effect of evident defects in a log is something the inexperienced cannot be told. Experience is required. The would-be logger may find after his logs are made that his price has been cut by a third because of some small specification that he did not understand.

Modern logging equipment has also contributed to the elimination of the farmer-owner from the logging field. The gasoline-powered two-man chain saw greatly increases the

output per man on a logging operation. Normally sawlogs are made by an experienced cross-cut gang at the rate of 1,000 - 2,000 board feet per day per man. Experienced chain saw gangs can make logs at 2,000 - 5,000 board feet per day per man. At the present time felling and log-making is paid for at $5 to $6 per thousand. It is natural that the apparent ease of power-sawing would make an owner hesitate to make logs by the laborious method of the cross-cut saw. The high cost (about $800) for power saws suitable for hardwood logging is beyond the average woodlot owner who has only limited use for such a saw unless he intends to do contract cutting. A given area can provide work for a relatively small number of power saws in relation to the number of woodlot owners and acres of woodland.

The skidding of sawlogs provides more farmer participation than any other phase of the logging operation. Skidding with horses is still the most satisfactory method. Handling of heavy logs (a 16-foot, 24-inch diameter, hard maple log might weight a ton) requires a good team, strong harness, and a capable teamster, particularly if the terrain is at all rough. Modern trends on the farm have in many cases replaced the heavy, well-trained work horse with the tractor. Currently operators will pay $4 per thousand board feet skidded. However, many large operators have to maintain their own stables and permanent teamsters. The team and teamster are sometimes hauled by truck 75 miles or more to skid logs.

The hauling of logs to the sawmill is the unquestioned field of the specialized logging truck. Buyers today pay on the average $10 per thousand for the delivery of logs from the skid at the edge of the woodlot to the mill. Even those owners who do carry out the logging operation are finding it necessary to leave log delivery to the truck.

Under present conditions of widely varied market requirements, small woodlot holdings, and the tendency of specialization of labour in the field that was once well

known to most of the rural population, there is limited opportunity for the average farmer to profit by attempting to be also a log-maker among his many other accomplishments. Evidently the logging industry will continue to become even more closely associated with the purchasing field. It is a business with many problems which can most efficiently be solved by the experts. The owner would do best to confine his efforts to growing the best logs possible. The marking of trees for removal is a silvicultural problem and should be carried out on the advice of the Zone Forester or other trained personnel; proper treatment of the woodland in logging greatly influences the growth rate, form of the trees, regeneration, composition and other aspects important to the future of the residual stand. Labour income can be realized by working for the logger or removing smaller products such as posts and fuelwood. The owner will probably realize most from his woodlot by extensive soliciting of tenders when logs can be made in his woodland. There are not enough logs to be cut that all owners can hope to learn how to interpret the market requirements and carry out their operations successfully from a financial viewpoint.

The utilization of the smaller woodlot products which the farmer can readily make and handle himself is good forestry and good conservation. Some of these products are fuelwood, pulpwood bolts, posts and poles. The removal of these products from the woodlot will, if properly carried out, increase the productivity of the woodlot and the gross returns per acre. Very often it is the difficulty of marketing low-grade material which makes it almost impossible to carry out the necessary improvement work and any means which can be discovered of utilizing small and poor-grade wood should be developed to the fullest extent.

At the present time interest is increasing in the possibility of manufacturing wood chips in the woodlot by means of portable chippers. Such chips can be used for the manufacture of pulp for paper, and as bedding for cattle and litter for chickens which can subsequently be spread on fields to increase the humus content of the soil. They can be made from any species of wood, and tops and branches can be utilized. The number of pulp companies which can use hardwoods is limited at the present time and only those making kraft paper can use chips containing bark, but the demand for hardwood chips will increase and portable barkers are being developed. Every woodlot owner should consider the possibility of improving the quality of his woodlot by utilizing the low-grade material as chips.

7. Stumpage Rates - Log Purchase Prices - Log Grades

An owner may wonder when the sale price at the mill for Select grade hard maple in two-inch stock is $200 per thousand and at the same time the price he receives for standing maple may average less than $40 per thousand for good trees. He should also note that No. 3 Common grade is probably selling at $40 per thousand and is not paying the mill its costs - and that high grades represent only a small percentage of the mill run, generally less than 15 per cent in hardwoods. The operator has to handle, manufacture and market large quantities of product of marginal and submarginal sale value in order to offer to the market the small percentage of high grades which puts the economic picture of the operation in a brighter light - higher grades must carry the "burden" of lower grades.

The amount of lumber that can be sawed from a log depends on the skill of the sawyer, number of defects present, shape of the log, thickness of the boards or timbers cut and the amount of saw kerf. The defects may be evident surface defects or hidden defects. Some evident defects are ingrown bark, ring shake, spiral or straight seams, "catface"

knots, live knots, dead branch stubs and centre defect. The effect on grade volume outturn of the various defects or combinations of defects is not easy to appraise. Only those with considerable experience at the head saw in a mill and in grading lumber can attempt this appraisal. Since probable grade output per log is important, the buyer considers this when buying stumpage or logs. Generally operators classify logs in at least two grades and often three or four. Prices paid are according to log grade.

Standard rules for grading logs do not exist. A first impression is that standards for woodlot products would be practical and would solve a lot of problems; that there should be some divisions in utilization for which standards could be established. When this theory is considered at length many problems arise. To cover all the aspects of log grading for the different market requirements would involve at best a long, technical, cumbersome schedule. Considerable intensive study is required to find a practical solution to this part of the complicated marketing problem. It is expected that in the near future the Research Council of Ontario will undertake a complete study of the marketing of woodlot products. The results of this study may provide the solution to some of the problems.

Some buyers attempt to keep log grading on the simplest basis possible and may have only two grades, whereas other buyers feel they must have four grades. Under present conditions each buyer has his own grade specifications. Sometimes they are rigid but often are quite flexible. The specifications are rarely published and available for comparison with other buyers' grades. The log grader simply keeps in mind certain basic principles and grades from knowledge of what can be produced from each log.

A good buyer, in making a stumpage purchase on a per thousand basis, will walk the woodlot with the owner and try to illustrate the various log grades according to external appearances. In this way the owner might get a fair idea of the probable log grade run in his sale. However, hidden defects may become evident when the logs are made and degrading may result.

Some buyers in competing for cutting rights emphasize the attractive price offered by quoting their highest grade price. They do not mention that only a very few logs will fall in this high price category, the majority of logs probably falling in the third grade. Sometimes a price list by log grades is provided, but no case was encountered where the specifications for the different grades were also set forth in general terms. An owner would have a better opportunity to compare buyers' offers for a stumpage transaction if written grade specifications were set against the grade prices. In addition the owner should require the buyer to illustrate his grading principles as far as possible on the trees he wishes to sell.

Buyers' needs for timber are different and fluctuate and so the amounts they will pay also vary. There may be special orders or contracts beyond the general sales. Such orders might call for concentration on elm of hockey-stick grade, basswood of key-stock grade, maple for heel stock, and so on. In some cases the buyers will pay premium prices for special logs that will satisfy good contracts. In other cases an order may allow certain defects such as dark heart or sound knots which may not generally be allowed in the average sales of that species, and a heavy run of rough logs may be allowed at good prices to satisfy a contract. At another time such rough logs would be of no interest to the buyer.

Log price lists and grade specifications are shown for three operators. Although the mills of these operators are not in the Thames Watershed, they are less than twenty miles from it, and a considerable part of their supply comes from woodlots within the Thames area.

Price lists for logs by grades mean nothing to a seller without some indication of grading specifications. Operators find it difficult to outline grading points. Admittedly it is difficult if there is an attempt to show each grade's limitations absolutely. But it is a help to know the general limitations of some of the variables that guide the grader.

It is useful to the seller to know that a 16-inch hard maple log 16 feet long and perfect in every respect (veneer grade) is valued at $80 per thousand board feet by Operator "B", at $100 by Operator "C"[1], while Operator "A" puts it in grade No. 3 at $35 per thousand because it does not meet his 18-inch diameter specification. A 20-inch hard maple log 16 feet long with a 3-inch centre defect but otherwise perfect is still worth $80 per thousand to Operator "B" who reduces the volume measure of the log an amount equivalent to the defective part; Operator "A" does not tolerate centre defect in grade No. 1 and puts the log in grade No. 2 at $55 per thousand. The premiums paid for lengths by Operator "C" indicate his interest in construction timber.

Much of the skepticism in the minds of woodlot owners toward dealings with log buyers would disappear if there were less obscuring of their grading standards. Some buyers feel they must say that they operate with "open books". Generally this is true. A good way to show this is to publish price lists and general log grade specifications together.

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1. Operator "C" has a special veneer grade price, although he does not use these logs for veneer; instead they are sawn for special stock. He has established this grade in order to compete against log buyers purchasing for veneer plants. Veneer logs have to be very high quality and the percentage in an average stand is generally very small. They are purchased at high prices. Thus this operator can point out to the woodlot owner that he will pay "veneer prices" for any veneer logs in the log run.

LOG PRICE LISTS 1950 - 1951 FOR THREE OPERATORS

WITH GENERAL LOG GRADE SPECIFICATIONS

OPERATOR "A" and **OPERATOR "B"**

SPECIES	Operator "A" Log Grade No.1	No.2	No.3	Operator "B"	Log Grade No.1	No.2	No.3
	$	$	$		$	$	$
WHITE OAK	75		35	Clear - 18" diam. & up	85	55	30
RED OAK	60		35	Clear - 18" diam. & up	85	55	30
HARD MAPLE	75	55	35		80	50	30
WHITE ASH	70		35		70	50	30
BASSWOOD	70		35		70	45	30
BLACK CHERRY	65		35		70	45	25
WHITE ELM	50		35	Good - 18" diam. & up	50	30	20
ROCK ELM				Good - 15" diam. & up	55	30	20
BEECH	50		35		45	30	20
BUTTERNUT					70	45	35
BIRCH					45	35	20
POPLAR					25	15	--
SOFT MAPLE					55	35	--
HICKORY					55	30	20
CHESTNUT					40	30	20
WILLOW							
WHITE PINE	Straight price 75				70	55	35
HEMLOCK	Straight price 70				45	30	--
TAMARACK							
SPRUCE							
CEDAR					33	23	

OPERATOR "C"

SPECIES	Length of Log 6'	8'	10'	12'	14'	16'	Special Prices for Good Diameters
	$	$	$	$	$	$	$
WHITE OAK	45	50	60	75	80	85	Over 16" diam.& 16' long 90
RED OAK	45	50	60	75	80	85	Over 16" diam.& 16' long 90
HARD MAPLE	40	50	60	70	75	80	" 16" " " " " 85
WHITE ASH	40	45	50	55	65	75	" 16" " " " " 80
BASSWOOD	40	50	60	70	75	80	" 15" " " " " 85
BLACK CHERRY	40	45	50	55	65	70	" 16" " " " " 75
WHITE ELM	40	45	50	55	65	70	" 16" " " " " 75
ROCK ELM	40	45	50	55	65	70	" 16" " " " " 75
BEECH	25	30	40	40	45	50	" 16" " " " " 55
BUTTERNUT	40	50	60	70	75	80	" 15" " " " " 85
BIRCH	40	50	60	70	75	80	" 16" " " " " 85
POPLAR	25	25	30	35	40	45	
SOFT MAPLE	35	40	45	50	60	65	" 15" " " " " 70
HICKORY	40	45	50	55	65	75	" 16" " " " " 80
CHESTNUT							
WILLOW	25	25	30	35	40	45	
WHITE PINE	40	50	60	70	75	80	" 16" " " " " 85
HEMLOCK	30	40	45	45	50	55	" 16" " " " " 60
TAMARACK	25	25	30	35	40	45	
SPRUCE	30	40	45	45	50	55	" 16" " " " " 60
CEDAR	30	40	45	45	50	55	" 16" " " " " 60

OPERATOR "C" (continued)

SPECIES	Length of Log 18'	20'	22'	24'	26'	28'	30'	32'
	$	$	$	$	$	$	$	$
WHITE OAK	90	95	Over 16" diam. - no defects - knots sound					
RED OAK	90	95						
BLACK CHERRY								
WHITE ELM	75	80	Over 18" diam. - sound & straight - knots no defects					
SOFT MAPLE	75	80	Over 18" diam. - sound & straight - knots no defects					
WHITE PINE	83	86	90	92	94	96	98	100
HEMLOCK	58	61	64	66	68	70	72	74

Above prices are for <u>No.1 Grade</u> logs	\$100 per M for "Veneer Quality" oak, hard maple or birch
For <u>No.2 Grade</u> logs deduct \$5 per M	\$5 per M over above prices for "white" basswood
For <u>Cull and Old Logs</u> deduct \$10 per M	\$5 per M over above prices for "clear" white pine

Note - Logs over 16' long are scaled twice, at small end and at centre of log.

<u>Prices of Operators "A","B","C"</u>, are per M Bd. Ft. log scale (generally Doyle Rule) delivered to the mill.

If the log seller does not carry out the operations of cut, skid, and haul to the mill, the operator <u>reduces</u> the above prices on a per thousand basis generally \$10 for haul, \$5 for skid and \$5 for cut. These are the average costs to the operators for these operations in the area studied.

GRADE SPECIFICATIONS OF OPERATOR "A"

Grade	Length	Diameter small end inside bark	Maximum allowable defect
1	8' up	18" up	up to 3 knots or indications of knots or injuries when 1 in middle and other 2 at same end fairly straight no centre defect
2	8' up	18" up	up to 5 knots or similar defect but 2 sides clear some crook allowed centre defect allowed - gross scale reduced
3	8' up	below 18"	logs that will not grade up to #2 because of imperfections or diameter

Hard maple has 3 grades designated No. 1, No. 2 and No. 3.

All other hardwood species have only 2 grades designated No. 1 and No. 3.
Grade 1 specifications are according to No. 1 above
Grade 3 includes all other logs

White pine and hemlock are not graded. Entire log run is accepted in the one price category.

GRADE SPECIFICATIONS OF OPERATORS "B"

Grade	Length	Diameter small end inside bark	Maximum allowable defect
1	8' up	no rigid requirement, but 14" is desired (some species are qualified as to diameter in price list)	2 knots or indications of knots or injuries when other three sides clear up to 5 small knots if all on one side and rest of log is very good fairly straight centre defect allowed - gross scale reduced
2	8' up	no rigid requirement	5 or 6 knots if fairly good log some crook allowed centre defect allowed - gross scale reduced
3	8' up	no rigid requirement	rough logs that will not grade up to #2 (not many logs graded as #3 in last few years)

GRADE SPECIFICATIONS OF OPERATOR "C"

Grade	Length	Diameter small end inside bark	Maximum allowable defect
Veneer Quality	Prices vary throughout all grades according to log length	not obtained (1) generally the veneer trade requires a 16" minimum with some acceptance of sizes down to 14" and occasionally lower	clear, no knots or indication of knots or injuries straight round very little taper no centre defect
1		no rigid requirement premium paid for good diameters and lengths	4 to 6 sound live knots depending on diameter and length of log fairly straight
2		as for #1	many knots considerable crook considerable spiral grain
Cull & old logs			extensive shake rotten knot holes logs left over from previous year (2)

(1) The system of log grading of this operator was under revision.

(2) Winter cut logs generally begin to decay or "sour" at the ends by mid-August in Southern Ontario.
Logs lying on the ground may sap rot if left too long or develop severe check.
Some species are susceptible to insect injury.

Without grading specifications in simple tabulated form, as well as log prices, the log seller is at a distinct disadvantage in selecting the best market for his logs. The seller rarely has opportunity to compare the grading points of different operators. The grading specifications shown are the answers given by the operators to direct questions.

8. <u>Species Sawn</u>

Cutting pressure on local softwoods for sawmilling is far more severe than on local hardwoods. By actual survey in 1950 the forest area of the watershed was classed as almost 93 per cent hardwood, about 5 per cent mixed hardwood and softwood, and the remainder as pure softwood. Much of the natural softwood growth is white cedar and very little of this is sawn for lumber. The sawmill operators indicated that the average annual cut is in the neighbourhood of 10 to 15 per cent softwood. The tendency to deplete available softwoods is a reflection of the high demand for construction wood in general and of farmers to have sawn softwoods rather than hardwoods at the mills doing custom work. Although the logs sawn in the area do not all come from the Thames Watershed, the tendency to deplete existing commercial softwood is nevertheless fact. It is a general condition in the parts of Southern Ontario which are basically agricultural.

The chief softwood species sawn are white pine and hemlock. Norway spruce planted along fence lines about sixty years ago for windbreaks is occasionally sawn. All of the local hardwoods are sawn but most of the sawing is hard maple, white elm, basswood and white ash. Other hardwoods sawn in lesser quantity are soft maple, beech, red and white oak, black cherry and poplar.

The slabs produced at the mills and the tree tops of the woods operations find a ready market as fuel, particularly in the larger centres of population. Fuelwood prices (1950-1951) of two operators, whose mills are located just off the watershed but who cut extensively within the watershed, are shown. Prices are for standard cords of 128 cubic feet - hardwood species.

	Operator No. 1	Operator No. 2
Slabs in stove lengths at mill	$9.50 for hard maple, beech, cherry and ash $6.50 for elm and soft maple	$10.00 ($12.00 delivered)
4-foot lengths from bush operation stacked in bush	$9.00 to $9.50 for better species $6.00 for elm and soft maple	$12.00 best species and sizes $8.00 poorer species and sizes (Add $4.00 for delivery)

The preceding cordwood operations are paid for at the rate of $4 per cord. A man described as a hard worker and a good cordwood maker made an average of 2.3 cords per day over a 7-day period.

One operator pointed out that county diameter limits on logging operations have put out of business "those people making fortunes out of fuelwood sale". The small diameter trees (6 to 12 inches) made excellent fuelwood at a fast rate, whereas the tops from logging operations are more difficult to make into fuelwood and do not bring such good prices as the material is rougher and there is less bodywood. In addition the operators must pay less for woodlots purchased on a lump sum basis because the buyer's realization on fuelwood is reduced.

Cedar poles and posts, recovered incidental to other woods operations or definitely sought as a merchantable product, find a ready market, and cedar is brought in from northern points to alleviate local shortage. Current prices (1950-1951) paid for cedar posts delivered in the yard are shown for a nearby mill which purchases within the watershed. The prices are paid on a diameter class basis and are for sound stock 8 feet in length.

Diameter Small end:	8"	8½"	9"	9½"	10"	10½"	11"	11½"	12"
Price: $	.80	.85	.90	.95	1.00	1.05	1.10	1.20	1.25

9. Product Outlets for Local Mills

The outlets for the production of small mills can be given four basic categories:

(a) Local farm consumption
(b) Local retail outlets
(c) Wholesalers
(d) Special industries

(a) Local Farm Consumption

About 60 per cent of the mills in the area can be described as farmer-operated. These are all low-production mills and most of their production is custom work for neighbouring farmers. Most of these operators claim they do custom work only, along with sawing for their own lumber needs. However the majority are in fact small retailers - keeping on hand a small quantity of stock for sale in the neighbourhood. Many of these farmer-operated mills - in fact, about half of all the mills in the area - have been established since the beginning of World War II. This is obviously an attempt to cut down the cost of lumber for their own needs or to "get in on" the rising lumber market, or both. This situation is not peculiar to the lumber market alone, it is part of the never-ending striving to eliminate the middleman in all fields of consumer purchasing. The process commonly produces new middlemen who exist by virtue of lower prices, often made possible by a poorer service or quality of product offered. Although the lumber purchaser may often be satisfied with a poorly sawn product for his need, at times such purchases may be false economy.

The data supplied by the mill operators indicate that about 45 per cent of all the output is custom work, and the greatest part of this is farmer business. This, coupled with mill operators carrying on small sales of their own stock to farmers and the purchases by farmers at local lumber dealer yards of some stock sawn locally, brings the total consumption by the farm of locally produced lumber to more than half of the output of local mills.

(b) Local Retail Outlets

Only a very small part of the production is sold through independent local retail yards; a small quantity of softwood production which is not custom work may be sold locally; however, the great demand for construction lumber makes it easy for the millman to sell this himself without putting it through the retail lumberyard channel. Retail lumberyards are primarily handlers of softwood lumber for construction. Generally more than 90 per cent of retail yard turnover is softwoods brought in from other parts of Canada, and of the 10 per cent handled which is hardwood, 90 per cent or more is "imported" hardwood flooring. This reduces the purchase of local hardwoods by retailers to a very small volume. However, retail yards which do some mill-working such as sash and door may purchase small quantities of local hardwoods for door sills, stair treads and risers, and so on. Occasionally a retail yard supplying one or more neighbouring small wood-specialty manufacturing establishments may stock small quantities of hardwood lumber to meet their needs.

(c) Wholesalers

The lumber wholesaler acts as a middleman between the producer and intermediate retailers or ultimate industrial consumers. Modern truck transport between the producer and his outlets, whether retailers or industrial consumers, have tended to eliminate the middleman relative to the mills in the area. However, small quantities of local production are handled by wholesalers, particularly better grades of maple which are for export to the United States.

(d) Special Industries

Special industries do not rely extensively on lumber supply from mills in the Thames area - the volume of farm consumption leaves little lumber for industrial supply. However, the buyers for special industries are a very important market for the small sawmiller, since hardwood finds only restricted use, relatively, in the construction field.

The major volume consumption of Canadian hardwood lumber is for hardwood flooring where the chief species used are birch and maple. Most of the oak flooring manufactured in Canada is made from American oak imported as rough stock. A small amount of maple, oak, beech, birch, elm and ash from the sawmills in the watershed is made into flooring.

The volume of hardwood available for the special industries market category is purchased in small lots from the various producers, chiefly by agricultural implement plants, manufacturers of hockey sticks and other sporting equipment, and furniture manufacturers; small enterprises manufacturing everything from lawn-mower rollers to ladder rungs complete the list. One of the mills consumes its entire production in its own box plant.

10. <u>The Marketing Problem</u>

The marketing problem has three closely related aspects:

(a) The woodlot owner who has merchantable trees that will make sawlogs. The sale of his woodlot increment should be a paying proposition the same as any agricultural enterprise.

(b) The professional or semi-professional sawmill operator who requires logs that he can mill into lumber on a paying basis.

(c) The ultimate industrial consumer who requires definite quantities of certain species in certain grades in order to carry on his annual manufacturing on a paying basis.

These aspects resolve into getting the woodland products to the mills in sufficient quantity to make their handling profitable to the woodlot owner and the sawmiller, and assuring the consumer a continuous supply of standard grades at fair prices.

In the past the farmer has been at a disadvantage in marketing logs from his woodland. In lump sum sale he must rely on his ability as a trader to strike the best possible bargain with the buyer. He is unfamiliar with methods of

estimating the quantity and value of his salable timber; experienced foresters find it difficult to estimate accurately cull and quality when appraising timber, particularly hardwoods, which predominate in the area studied. The buyer has had experience in this field and in addition allows a safety margin on the estimate. Furthermore, operators of small mills and portable mills are often at a disadvantage in marketing their lumber and so are not in a position to pay full value for standing timber. Sale methods involving stripping the woodland ruin the woodlot for decades to come. Sale by set price per thousand board feet removed gives the operator the right to cut all or certain trees above a specified diameter and to take only those portions of the trees he wishes and to pay for only the portion he takes. This pattern of sale removes the uncertainty of the cull and quality factors but introduces the question of how much of the timber cut will actually be taken; it often is highgrading the woodlot and "creaming" the logs of the felled trees. Thus a high price offer per thousand on the stump may bring a lower price to the farmer than the lump sum method. The log scale used in buying standing timber introduces another variable. Opportunity for sharp practice in scaling the felled logs exists, particularly when allowance is made for cull in defective timber. However, in fairness to log buyers it must be said that the majority are not the type to employ such practices.

The professional or semi-professional sawmiller requires assurance of log supply. The complete lack of interest by the majority of woodlot owners in any form of logging operation of their woodlots forces him to sell the idea of log sale to the owners. To assure log supply to his sawmill he is in many cases forced to buy woodlots in order to plan his milling for the year. Sporadic supply by purchase on the open log market is too indefinite. In buying woodland

for a season's milling he may acquire such volume as to remove strong interest in log purchase from individual farmers in small quantities. The disposition of his cut is often quite a problem. The preponderance of low grades in average hardwood milling, in many cases increased by poor sawing equipment and techniques (especially degrading due to poor piling), make efficient grading and separate piling of the many species sawn a serious problem. The resulting common practice is mixed-grade piling and forces him to deal lumber piles at reduced prices rather than at good prices by specific grades. His established market has considerable dependence upon mutual goodwill with the purchaser.

The industrial consumer most often requires quantities and specific grades in large lots of a carload (approximately 20,000 board feet) and up. He wants well-sawn products of standard widths and thicknesses. Most large consumers must "import" other than local species from large mills which also handle large quantities of well-graded woods which may be sawn locally. It is more practical from his point of view to pay the extra freight costs involved to be assured of continuous supply of species and grades as required than to "shop around" in the uncertain local supply market.

11. Attempts at a Solution of the Marketing Problem

(a) A Marketing Experiment near Doon

During the winter season of 1948 and 1949 the Department of Lands and Forests in the Galt Zone carried out an experiment in the marking and marketing of timber in an 18-acre woodlot near Doon. The project was initiated by Mr. I.C. Marritt, the District Forester, and the field work was done by Mr. L.S. Hamilton, Zone Forester. The scheme is patterned after a marketing assistance method meeting good success in the State of New Jersey.

The mixed uneven-aged woodlot contained considerable large white pine and red oak. Initial investigation by the Department showed growth stagnation due to overstocking and recommended the removal of certain trees representing the accumulation of growth over a number of years. Under this condition, removal of selected trees reduces the growth stagnation factor and the remaining trees grow at an increased rate. As growth again slows down another cropping should take place. This is the simple principle of selective logging - the removal of accumulated growth periodically to keep the stand at a healthy, productive growth rate.

Upon explanation of the proposed marketing assistance, the woodlot owner entered into a signed agreement with the Department as a co-operator, agreeing not to sell or allow to be cut any trees except those marked, upon penalty of a nominal fine per thousand for the estimating and marking service of the Department.

The trees were marked with a view to a second marking which would be necessary afterwards to remove weed trees and trees of low value in order to give good growing conditions. Each tree marked for removal was blazed at breast height and below stump height; the stump blaze being branded to detect any unauthorized cutting. The total log scale estimated for the 223 trees marked was 47,600 board feet Doyle Rule. The trees were tabled as to species and diameter on a mimeographed form.

All the estimation data were turned over to a timber agent chosen by the Department. The timber agent entered into written agreement with the owner to

(1) solicit tenders from buyers;

(2) draw up a timber sale contract protecting the owner;

(3) check on cutting operations; and

(4) measure and collect payment for all wood cut before its removal from the property.

The agent was to receive a percentage commission on the gross sale value.

The timber agent mailed the volume estimate sheets to all local log-buyers, giving location of the woodlot and inviting inspection of the bush.

The timber sale contract set forth the prices agreed upon for the different species, required that tops be worked into 4-foot wood to be paid for at an agreed price per standard cord, provided penalties for the cutting of unmarked trees, and required that the woods operation be conducted with a minimum of damage to the woodlot.

Prices realized by the owner were much better than the average paid in the area. Prices per thousand board feet Doyle Rule were:

White and red oak	$62
White ash, soft maple, hard maple, basswood and cherry	$60
White pine	$55
Hemlock	$45
Beech	$30

Fuelwood - $4 per standard cord

The experiment was considered very successful by all the parties concerned, yielding about 2,000 board feet more than was estimated, and the woodlot has been left in fine growing condition with an expected second cut in fifteen or twenty years of 25,000 board feet.

(b) <u>Forest Products Co-Operative in New York State</u>

In Otsego County in New York State local interest in forestry, stimulated by critical needs arising from the depression, resulted in the organization of the Otsego Forest Products Co-operative Association at Phoenix near Cooperstown in 1935 as a farmer co-operative under the co-operative corporation laws of New York State. In its certificate of incorporation the objectives of the Association are stated:

> "To promote, foster, and encourage the better care and increased productivity of woodlands, the orderly and efficient marketing of forest products through co-operation to eliminate speculation and waste, and to stabilize the marketing of forest products."

A survey covering a radius of 35 miles from Cooperstown indicated about 2 billion feet of merchantable timber, a fair portion of which could be available to the Co-operative. In 1937 a loan was arranged with the Farm Security Administration to construct and operate a farmer-owned processing plant. Since that time this association has afforded farmers within an increasing radius (now about 50 miles and occasionally up to 90 miles) an opportunity to practise forestry in conjunction with their usual farming enterprises on a basis that assures equitable return from any species and grade of product in whatever quantity offered. The program requires change from the common stripping of woodland and of utilizing only the best trees of a few species, to selective logging and diversified utilization whereby the forests will be managed for a continuous high-valued yield.

Otsego County, in which the centre of the mill-servicing area is located, is not unlike much of Southern Ontario. The county is dominated by dairying; about 62 per cent of the land is used for crops and pasture; 28 per cent is in forest; the remaining 10 per cent is abandoned farmland (reverted to brush), water, roads, marsh, building sites, and so on.

The Association is composed of members and operated by a Board of nine Directors elected by members at an annual meeting. The Manager is appointed by the Board and is assisted by an office manager, a complete mill crew, and fieldmen who handle member contracts and all phases of the field activities.

To become a member a person must be a woodlot owner, must purchase five shares of common stock at $1.00 per share and must sign the Association's Marketing Agreement. The member thereby agrees to manage his woodlot according to good forestry practices and to sell any sawlogs cut by him for sale to the Co-operative and to accept 5 per cent of the value of his logs in common stock. Members receive patronage

dividends. The Association agrees to assist the owner in applying good forest practices to his woodlot and to publish prices and grading specifications for logs on a delivered-to-the-mill basis and, should it be unable to handle the member's forest products advantageously, to give permission to sell them elsewhere. Lumber needs of members are met at wholesale prices at the mill. By 1941 the Association had a membership of over 600; this had increased to almost 1,100 by the spring of 1950.

The Association's fieldmen will, on request and without charge, cruise a member's woodlot and mark it for cutting, telling him the number and volume by species of trees in his woodlot and the physical condition of the stand. The marking viewpoint is to improve the woodlot by removal of mature trees and leave the young and medium-sized trees of commercial species to grow.

The plant of the Association is modern and equipped to get the most out of the log at a minimum of cost and waste. It has a hot log-pond, a modern band mill, a small circular mill, edgers, trimmers, slabsaws, planing mill, small resaw, and mechanical conveyors to the sorting and grading deck. The equipment is powered by electricity and steam. A very important feature of the plant is its battery of dry kilns. There is rail service into the mill-yard.

The mill cuts annually between 2½ and 3 million board feet of lumber, which holds consistently to 66 per cent hardwood and 34 per cent softwood. Mill operation is on a three-day week basis, it being established that full-time operation would too rapidly deplete the timber resources of the area which can be economically serviced. The 12-man crew works the remainder of the week on lumber handling. The daily cutting rate is 20,000 board feet of softwood or 15,000 to 16,000 board feet of hardwood.

The Association publishes a leaflet every two months which is sent to each member. It describes activities and facts about the Association, and farm forestry practices

in general which are of interest to the members. Through it the members are posted on current log prices at the mill by species and log grades and the standard log grades of the mill are set forth in detail. The following is the log grade specification and log price effective August 1, 1950.

LOG PRICE LIST

PRICE: (Per M Doyle Scale Delivered at Plant, Phoenix Mills, N. Y.)

	Species	Log Grade			
		Select	No. 1	No. 2	No. 3
		Price per M Bd. Ft. ($)			
A	Hard Maple Ash Basswood Black Cherry Birch	60.00	50.00	33.00	18.00
B	White Pine	60.00	50.00	38.00	18.00
C	Red Oak	47.00	37.00	30.00	18.00
D	Beech Elm Soft Maple	35.00	30.00	23.00	18.00

E Hemlock
$39.00 per M for logs, 8,10,12,14 foot lengths
$42.00 per M for logs,16,18,20 foot lengths

Demonstrating in many ways the economic advantages of co-operative action, the Association has largely overcome many of the obstacles that make intensive forest management on a continuous yield basis impractical without a market that will absorb all classes of products, pay fair prices and accept delivery in small quantities from widely dispersed farm forestry enterprises.

(c) The Lanark County Co-Operative

Mr. W.E. Steele, District Forester at Kemptville in Grenville County, supplied the factual data upon which are made the following comments on the Lanark County Co-operative for marketing woodlot products.

The Co-operative was set up by a group of woodland owners in the County of Lanark in March 1950. Its objectives are the better management of privately owned woodland to ensure a continuous yield of the best material possible from the forested land of the members through profitable marketing of all the woodland products.

To put the woodland enterprise on a paying basis to the individual it is necessary to market not only the material suitable for lumber manufacture and special products such as veneer, but also the inferior products such as the poorer hardwood species, low-grade hardwood logs of the better species, small softwood products such as cedar posts and poles, and that material removed in improving a woodlot during what may be called sanitation cuttings. It was felt that the advantages of co-operative action by woodland owners in the field of marketing would best solve the problems of the individual, particularly in respect to inferior or small products. Acting as a group rather than individually and through a member active in contacting prospective buyers, they can hope for recognition by the buyers in the area as a stable source of the various woodland products.

The establishment of the Co-operative followed an extensive educational campaign carried on by fieldmen of the Federation of Agriculture, the Department of Lands and Forests, and the local Farm Forum leader. Interest was aroused through moving-pictures, talks at schools, local evening meetings, press releases, radio programs and public speaking competitions on woodlot management. Meetings held at Lanark were attended by officers of the Department of Lands and Forests; representatives of pulp and paper companies, sawmills, and other wood-using industries; and members of agricultural organizations. Gradually a workable plan was evolved and the Lanark Forest Co-operative was set up under a number of directors with Mr. Herb Paul as manager.

Mr. Paul of Lavant, the main force behind the formation of the Co-operative, is an energetic leader of the local Farm Forum, caretaker of the Lanark County Forest, a farmer and owner of several hundred acres of woodland in Lavant Township. As manager of the Co-operative his duties entail the location of markets for the woodland products of the members, arriving at satisfactory price schedules, collection of payment for products, ensuring that products are ready or delivered at the time promised, and advising members on cutting their woodland according to best forestry practices.

By the fall of 1950 membership in the Co-operative was approximately 60, with an increasing interest in its operations prevalent. The membership fee is $5 and in addition the Co-operative takes 5 per cent of the sale proceeds of products handled. The member pledges to supply the quantity of material at the time and place agreed and to practise woodlot management according to conservation principles.

At present the Co-operative has no intention of undertaking a manufacturing endeavour such as a sawmill for lumber or railway ties. Logs are not accumulated at a central point and sorted as to species and a grading standard, but are handled direct from woodland to buyer. The purchaser's

measure of the volume, by grade where it might apply, is accepted as the basis for payment on transactions.

An objective of the Co-operative, stated as the better management of privately owned woodland to ensure a continuous yield of the best material possible, is a highly commendable aim. However, the statement embodies a tremendous amount of field work on the part of those capable of advising on the subject of woodlot management. This is a job requiring experienced field personnel. At present, although the Department of Lands and Forests is following this development in marketing with interest and co-operation, it has not the staff of extension foresters to provide the many owners of farm woodland with the guidance that is necessary. If the farm woodlot is to assume its place in the economics of the farming enterprise it must be shown that it pays in dollars and cents to the owner. The average woodlot owner cannot afford to carry on practices at a financial loss in the interest of the region or posterity. If, in its infancy, the Co-operative manages to make dollars and cents for its members by the sale of those products generally difficult to market as well as those relatively easy to market, and does the best it can toward field guidance on woodlot management for perpetual yield, then it will have done a lot toward good forestry in its area.

APPENDIX A

AGREEMENT BETWEEN THE ONTARIO DEPARTMENT OF LANDS AND FORESTS AND THE UPPER THAMES RIVER CONSERVATION AUTHORITY COVERING FOREST LANDS

AGREEMENT made in triplicate this 11th day of April, 1951, pursuant to The Forestry Act, Chapter 147, R.S.O. 1950, and The Conservation Authorities Act, Chapter 62, 1950;

B E T W E E N:

HIS MAJESTY THE KING, in right of the Province of Ontario as represented by the Minister of Lands and Forests, hereinafter called the "Minister"

OF THE FIRST PART;

-and-

THE UPPER THAMES RIVER CONSERVATION AUTHORITY, hereinafter called the "Authority",

OF THE SECOND PART;

WHEREAS the Authority proposes to purchase for reforestation purposes lands in the Upper Thames River Watershed, and is desirous of entering into an agreement with the Minister for developing, protecting, caring for and managing the said lands, pursuant to The Conservation Authorities Act, 1950:

NOW THIS INDENTURE WITNESSETH that in consideration of the premises it is hereby agreed by and between the Parties of the First and Second Parts hereto as follows:

1. The Minister shall, until 2000 A.D., have sole and exclusive possession, control, management and care of any lands acquired hereunder, and shall and will, until 2000 A.D., at his own expense (less such sums of monies as shall have been received by the Minister for timber sold and revenues of any kind out of the said lands and improvements thereon) reforest, develop and manage the said lands, and will supply and plant trees deemed by the Minister best suited for the purpose of reforestation, and shall furnish all necessary equipment therefor, and shall erect and maintain during the said period all necessary fences and improvements; and, subject to his direction, the work of reforestation on the said lands shall be conducted in accordance with approved forestry methods.

2. The Crown agrees to contribute fifty percent (50%) of the cost of all land acquired by the Authority for the purpose of reforestation, provided the Minister shall approve in writing of purchases of land.

3. During the year 2000 the Authority shall have and exercise one of the following options, (A), (B) or (C):

   (A) During the year 2000 the Authority shall pay to the Crown one-half of the cost which shall have been incurred by the Minister in maintaining, managing, reforesting and developing the lands,

and the cost of constructing and maintaining fences, buildings and equipment thereon, provided that any monies received by the Minister from the said lands shall be deductible from such payment; and upon such payment the Authority shall share equally with the Minister the cost and expense thereafter incurred in maintaining, managing, reforesting and developing the said lands and improvements, and in the cost of the utilization of the timber upon the said lands from time to time, and shall share equally with the Crown any profits derived from the utilization and sale of any timber upon the said lands. The operation, control and management of the said lands and timber is to continue under the direction and control of the Minister; or

(B) During the year 2000 the Authority shall pay to the Crown, without interest, all monies which shall have been expended by the Minister in the maintenance of the improvements and equipment on the said lands, but any monies received by the Minister from the said lands shall be deductible from such payment; and upon such payment the Authority shall have possession and control of the said lands, subject to the written consent of the Minister for the utilization of any of the timber upon the said lands; or

(C) The Authority shall grant the said lands to the Crown in fee simple, free of all encumbrances, together with all improvements and equipment thereon, and the Minister shall pay to the Authority the purchase price of the said lands, without interest, and the payments provided for under clause 2 hereof shall be credited against such payment.

4. In the event that the Authority exercises Option (B), the Minister undertakes and agrees to give to the Authority such technical advice respecting the continued reforestation and management of the said lands as the Authority may from time to time require.

5. Should the Authority fail to exercise any of the above Options (A), (B) or (C), the Minister may designate the option by which the Authority shall be bound.

6. Upon the Minister designating the option, the Authority shall forthwith comply with and carry out the terms of the option so designated.

7. This Agreement shall be binding upon the Party of the First Part and the Authority, its successors and assigns.

IN WITNESS WHEREOF the Minister of Lands and Forests for the Province of Ontario has hereunto set his hand and the seal of the Department of Lands and Forests, and the Chairman and Vice-Chairman of The Upper Thames River Conservation Authority have hereunto set their hands on behalf of the said Authority, and attached the seal thereof.

SIGNED, SEALED AND DELIVERED in the presence of:	H. R. SCOTT Minister of Lands and Forests for the Province of Ontario
E. J. ZAVITZ	
	THE UPPER THAMES RIVER CONSERVATION AUTHORITY,
L. N. JOHNSON Sec. Treas. U.T.R.C.A.	BY: J. CAMERON WILSON Chairman
	AND: G. W. PITTOCK Vice-Chairman

WATER

CHAPTER 1

THE RIVER

1. Tributaries and Watershed Areas

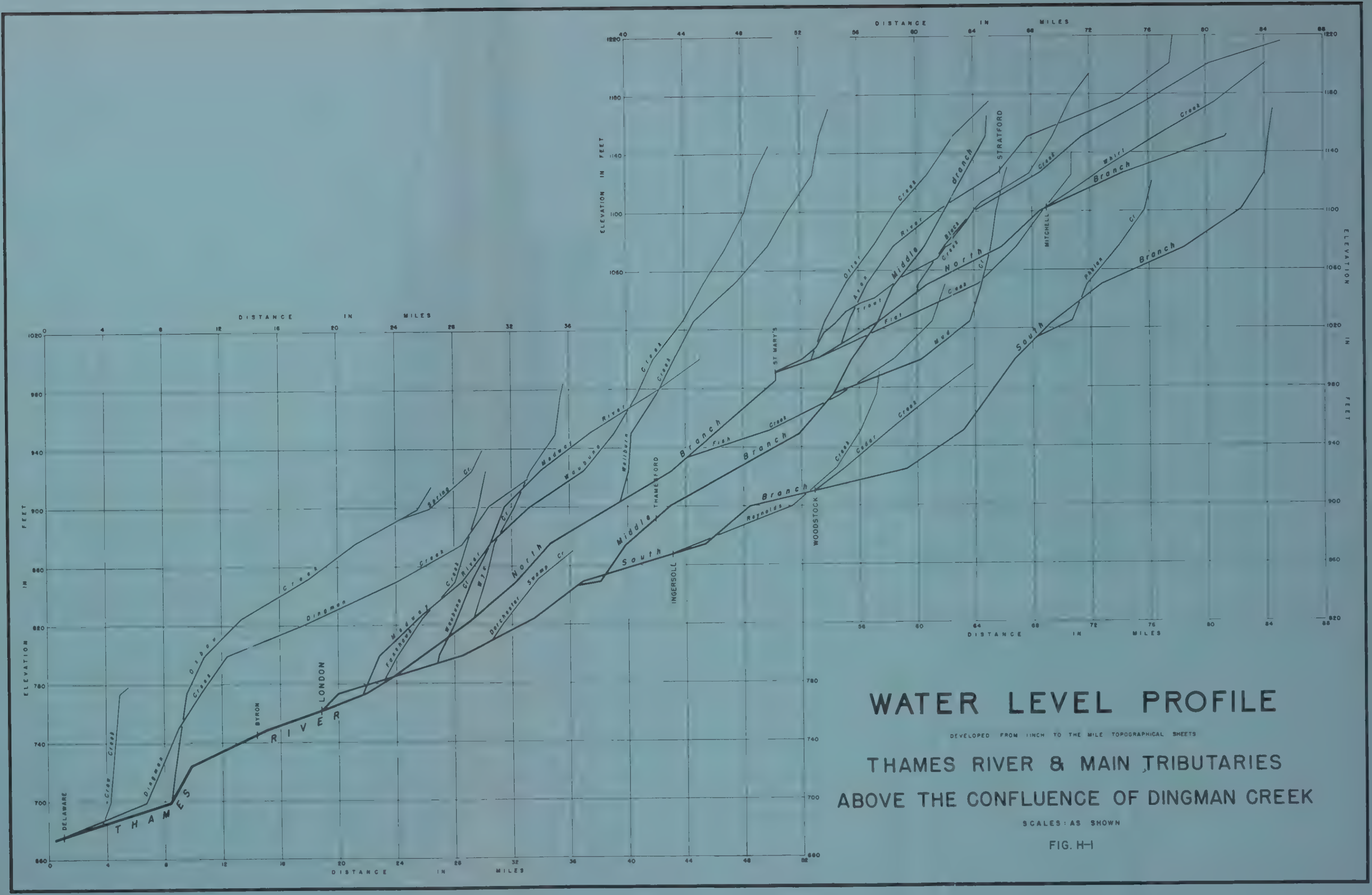
The Thames River drains 2,252 square miles of densely populated and for the most part excellent farmland in Southern Ontario. It rises in the highlands of Perth and Oxford Counties northeast of London and carries water more than 190 miles to Lake St. Clair. Characteristics of the watershed suggest the division of the river into two sections, one above Delaware, the other below.

Above London the Thames has many tributaries all of which drain into three main branches, namely, the North Branch, with a drainage area of 661.4 square miles, the South Branch with a drainage area of 396.4 square miles and the Middle Branch which joins the South Branch approximately five miles west of Ingersoll with a drainage area of 132.8 square miles. The South Branch joins the North Branch in the city of London, the whole drainage area above this point being 1,190.6 square miles.

Tributaries of the above three main branches and their approximate drainage areas are as follows:

	Tributary	Area-Square Miles
North Branch:		
	Medway River	74.7
	Wye Creek	21.8
	Fish Creek	58.7
	Trout Creek	64.8
	Flat Creek	33.9
	Avon River	59.1
	Black Creek	62.8
	Whirl Creek	55.0
South Branch:		
	Waubuno Creek	39.3
	Reynolds Creek	58.7
	Cedar Creek	37.6
Middle Branch:		
	Mud Creek	26.9
	North Branch Creek	37.7

The drop in elevation from the source of the North Branch to London is fairly uniform at about 7 feet per mile. The South Branch drops more rapidly for the first twenty



WATER LEVEL PROFILE

DEVELOPED FROM 1 INCH TO THE MILE TOPOGRAPHICAL SHEETS

THAMES RIVER & MAIN TRIBUTARIES ABOVE THE CONFLUENCE OF DINGMAN CREEK

SCALES: AS SHOWN

FIG. H-1

miles at about 11 feet per mile, then levels off to $4\frac{1}{2}$ feet per mile. The Middle Branch drops at about 11 feet per mile through Thamesford.

Below London the Thames flows through a comparatively narrow watershed, the slope becoming less severe as the lake is approached. From Chatham to the lake there is practically no drop in elevation. Most of the tributaries are comparatively small, three of the largest being Dingman Creek, draining 58 square miles, Oxbow Creek, 35 square miles, and Crow Creek 12 square miles.

2. Summer Flow

The problem of summer flow is not so acute on the Thames as it has become on some other rivers in Ontario. Even during the period of low flow in the late summer months, there is usually enough water in the main branches to prevent excessive pollution.

Wide variations in the volume of flow were normal in the earliest times of settlement. The printed descriptions of the area are apt to dwell on possibilities of navigation and ignore the fact that this navigation was seasonal. On the other hand, the manuscript reports of the first systematic examinations of the Thames contain statements that at many places above Thamesville a loaded canoe could hardly pass in the "dry season". Descriptions of the difficulty of using canoes between Moraviantown and London, and still more between London and Woodstock, are found in several Diaries of Survey from 1796 to 1812, sometimes in periods of normally wet weather. Part of the trouble was due to obstructions, but the depths recorded by Augustus Jones in January 1793 between Muncey and Woodstock show that shallow water was a contributing factor and that these complaints were not merely excuses for delay on the part of the surveyors. Most of the references to rafting are for the periods of spring and autumn freshet and this seems to have been accepted as the normal condition.

There are, however, a few records of rafts or small boats being used above London in June and evidence can be produced that this was possible around 1860, when mill dams and weirs had raised the level in many places.

Nevertheless, it would have been less misleading if the writers of the 1830's and 1840's had added Jones'words "in the spring and autumn floods" to their statements that the Thames was navigable from Louisville to London for boats and barges and to Woodstock for small boats and rafts. This navigation was of great use to the earliest settlers and the later lumbermen, but it was always precarious and in years of drought it sometimes became impossible even at the freshet. These years of drought, when swamps and creeks were dry and mills idle for lack of water, are recorded quite often in the 1820's and 1830's, but the complaints of water shortage do not come from the millers and farmers on the Upper Thames. It is probable that there was always a sufficient flow in the river and that, if it had been confined in a narrower channel, barge navigation could have been made permanent with a moderate amount of water storage. Some canal schemes were seriously proposed before 1830, but long before sufficient means were available to carry them out railways were making inland water transport obsolete even for heavy freight.

The fluctuations in flow appear to have been less before the clearing of the forests. The river on the average seems to have had more water in summer than is now the case. It is plain that many of the tributaries had longer courses before 1880, and some streams which are now dry in summer were then flowing all year round. The cutting of remaining woodlots since that time and the draining of swamps and wet land have reduced the amount of water storage so as to have a marked effect on the river. The references to trout being caught even in the larger tributaries of the Thames, in early times, show that a change has taken place in the river

which is not entirely due to the pollution of the water. In some cases mills were located on small streams which would not now provide enough power to run them during most of the year. As early as 1895 a complaint of decreased flow in the Thames is found in the St. Marys Argus. It is probable that since 1860 the bed of the river in many places has been scoured out and the banks undermined by floods so that the streams run broader and shallower than before. In a few places the river bed has been artificially widened and deepened as a measure of flood protection.

The records of stream flow near London, which have been kept for the past thirty years, indicate that September is normally the month of lowest flow on the North Branch and August on the South Branch. Years of low flow in the summer and autumn have been frequent; the most pronounced period occurring in 1936, on both branches. In that year the combined flow of both branches averaged 45 cubic feet per second for the three months of July, August and September, and for the four months of July, August, September and October the flow was 57 cubic feet per second.

There is no evidence that this condition is becoming more pronounced of late years, and complaints of the unpleasant consequences of low flow are only met with in a few localities. A better regulated flow in summer would, however, be very desirable as population and unavoidable pollution increase, especially if the possibilities of the river for recreation are to be developed to the full. The planting and protection of source areas, highly desirable for other reasons, would have a great effect in increasing the volume of water in dry seasons, and this could be supplemented from the reservoirs necessary to control floods and from recreational lakes.

3. <u>Encroachments</u>

Encroachments include any works of man which are built on the natural flood channel of a river. These flood

channels may not be used by the river for several years, but at certain intervals, due to excessive precipitation and other factors, this supplementary channel which it has created for itself will most certainly be flooded, because it must be remembered that flooding is a natural phenomenon of rivers. As early as 1541, when DeSoto came up the Mississippi, he recorded "floods to the height of the treetops for miles back of the river". Also Zeisberger, visiting the Thames in 1792, stated, "We found out and saw that in the spring the river rises twenty feet or more. Therefore, all the bottoms are covered."

In the process of settling a new country, encroachments are often unavoidable because, as is well known, many of our towns and cities were established by the erection of a mill on the river or at the junction of a small stream with a larger one. Gradually as time went on, other businesses followed, shopping districts were built up and spread out around this nucleus of settlement. Thus it happens that such towns, or the older part of them at least, are completely within the flood channel, and when high water occurs, they, of course, are flooded.

In the Upper Thames Watershed, however, St. Marys is the only place of any size in which much of the main streets are exposed to serious flooding. The sites of the three cities and of Mitchell were chosen because of their relation to the navigation of the river or to road intersections and river crossings, and the two last influenced the placing of some smaller villages. When regular townplots were surveyed they were placed in almost every case on higher ground outside the natural flood channel. Mill sites were found adjoining these plots and as the town grew industry tended to be concentrated along the rivers. Waterpower was at first the only form of power and up to 1850 remained the cheapest. The railways were built along the valleys and this tended to keep industry close

to the river and owing to lack of transportation residential areas grew up near the mills and factories. As the cities grew and real estate became more valuable, there was further crowding into the flood channel where the land was considered less desirable and could be purchased at a cheaper rate.

Moreover, as such encroachments were in progress, and particularly if the river did not flood severely for ten or twelve years, people began to think that severe floods would not occur again. This, of course, is an example of foolish wishful thinking because the records show that the rivers of Southern Ontario do flood systematically, and of late years these floods have become more severe; both from the standpoint of high water and damage to structures which have been built in the flood channel.

The presence of encroachments such as narrow bridges with abutments projecting out into the river valley, factories, buildings and so forth, not only aggravate the flood situation from the standpoint of preventing the free passage of water but also by piling up large cakes of ice which naturally float on the crest of the stream in the spring, accumulating behind these structures and building up a damgerous dam only to break when the pressure becomes too great or the temperature modifies. These encroachments together with the gradual denudation of the forest, especially at the headwaters of the rivers, have aggravated the flood situation on most of our streams in Southern Ontario, and it is largely due to these causes that some major works must be undertaken chiefly in the building of dams or the building of dikes in order to protect the towns and cities which occupy the river channel in whole or in part at certain points on its course.

The problem of encroachments has been pertinently summed up by a U.S. Army Engineer as follows: "When we are honest with ourselves and get down to the bottom of the flood problem, about 90% of perennial flood damage is a result of

man's damn foolishness in building his roads, railroads, factories, houses, farms and whatnot on land that plainly belonged to the river. When he built there, the evidence that the river had used that land for flood purposes was plainly visible, and when that evidence is there you can be darn sure the river will again flood that land. It would be much simpler and more economical to retire from human occupancy and use these perennially flooded river bottoms and give them back to the river for flood purposes."[1]

This is an arresting statement, but of course impracticable where settlement has advanced to the extent of millions of dollars in real estate. It does, however, set forth clearly the relationship between flooding and encroachments.

If an examination is made of the towns and villages which occupy a part of the natural flood channel of the Thames River and its branches, it will be seen that over the years many structures have been built which have aggravated the flood situation. The scope of this report did not permit of making a careful examination of all these, but in order to illustrate what is meant by this interference an examination was made of some of the more obvious encroachments which occur in the city of London which, as is well known, has been visited by serious floods within the memory of many living in that city.

One of the most serious encroachments is the C.N.R. embankment approaching the east end of Cove Bridge. This embankment entirely fills the old flood channels leading to the Cove and the bridge itself is so placed that it causes an abrupt change in the course of the river. In addition the old pile footings from former piers have been left in the channel

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1. This was actually done at Weston, Ontario, after the flood of 1850. The older part of the village was wiped out and its inhabitants built on the high ground.

and these aggravate the situation, particularly when there is likelihood of an ice-jam.

Another type of encroachment within the limits of the city are the dikes which have been built to keep the banks of the river in check. These of course were necessary but are an example of how such structures crowd into the natural flood channel.

An old encroachment which has been forgotten is to be seen at the Dennis Iron Works at the foot of Carling Street, at the Forks. The east bank of the North Branch has been filled in westward over 100 feet.

If the extensive system of dams recommended elsewhere in this report is built to adequately safeguard the towns and cities on the Thames River from any anticipated floods, very careful consideration should be given by all municipalities to the controlling of further encroachments in the flood channel. It is not only possible but highly probable that, if encroachments are continued as they are being carried out at the present time in certain areas, in years to come works for the prevention of floods will be greatly minimized. Therefore, one of the chief concerns of the Authority in planning a long-time programme for the river valley should be to control and check further encroachments on the river, especially where they are costly permanent structures and will involve the loss of property, goods or human life.

CHAPTER 2

FLOODS

The flood on the Thames River at London in April 1937 brought the question of floods and flood damage more forcibly before the public than had been the case at any time since the early years of this century. It was the highest flood recorded on the Thames, and was also the most destructive of property. In discussions of this flood and of those which had occurred in the past, it was often taken for granted that floods of a serious nature on the Thames were comparatively modern phenomena, directly connected with the spread of settlement and the clearing of the forest. It was said, truly enough that there were no accurate and scientific measurements of the flow of the river or the height of the floods until after 1938. Such accounts of early floods as were known to exist were considered unreliable, not only on the reasonable ground of the lack of scientific data, but also in the belief that their authors had exaggerated the severity of the flooding owing to the fact that, being unused to serious floods, they had no standard of comparison. The following account of floods on the Thames between 1791 and 1951 is intended to throw some light on the number and extent of these floods, the weather condition when they occurred, the amount of property damage and the effect which settlement in the area had on flooding.

The first settlers, coming to the Thames Valley from lands where much greater floods were not uncommon, regarded the freshets as a seasonal convenience or an unavoidable nuisance, according to whether they made use of them for navigation or suffered inconvenience or loss from the high water. It is usually in the latter case that references occur in notes or diaries of survey, in petitions, letters or private journals and memoirs. A number of such references have been found, but there are gaps in the record that might be filled by further research if time and means allowed. Many

of these early references are vague and general, the most useful being those of the surveyors.

Even when the latter do not record a particular flood, their accounts of the evidence of flooding are of interest as showing that the authorities were aware of the flood hazard and influenced by this in placing townplots. For example, both David W. Smith, Acting Surveyor-General of Upper Canada, and Augustus Jones, Deputy Surveyor, believed in 1793 that the backwater or oxbow, called the Cove, at London had been formed fairly recently by the river cutting across the bend.* Jones gives the usual rise in spring at Muncey as about ten feet and at the Forks as between six and seven feet. He made these observations in the second half of January 1793. Smith, attending Lieutenant-Governor Simcoe on his return from his first visit to Detroit in March 1793, makes a number of notes on the topography of "the Forks" and says of the flats in the northwest angle of the Forks: "The River has made efforts to go through the angular part of this Plain adjoining the Fork, and a Gully remains testimonial of the circumstance; it is probable also that this Plain may have been overflowed, but I am of opinion it is not so - communibus annis." (sic). Later he says: "On the South side of the River, below and adjoining the fork is also high Land of about 100 feet above the water, except at the point, where is a piece of low broken ground and has the appearance of having been overflowed, there is somewhat like a deserted channel, or rather vestiges of an effort in the River, to take its course across the point when the flood is great." In 1826, after surveying the townplot of London, Colonel Mahlon Burwell reports the same behaviour on the part of the North Branch in flood, and indicated on his plan the course of the water across the eastern boundary of the present Labatt Park and the opposite flat, as far as the high ground, with the crescent shaped chan-

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* Department of Lands and Forests, Toronto; Survey Records; Field Notes, Vol. I, pp. 191-199 - "Thames - Its Banks", D. W. Smith, Actg. Surveyor-General, & pp. 200-211, "Thames River - January - February 1793", Augustus Jones, D.P.S. Smith says "it is said" that the new channel had been made "of late years", Jones only implies that it was recent.

nel by which the floods returned to the main stream below the Forks.* This was the course of the average flood, for if Simcoe and his party had remained another week in the vicinity of the Forks, they would have probably been in no doubt that the "plain" was overflowed, 1793 being an "uncommon" year as far as the spring freshet was concerned. These observations certainly had some influence on the placing of the site of London.

A fairly full record of floods on the Thames is available between 1791 and 1800; during the next fifty years fewer references have been found. The newspapers are of little use in this period. There were none published in the London District before 1830 and those published elsewhere contain few accounts of floods. The newspapers of the day gave little space to local happenings except of a political character. News travels fast in a small community and by the time the weekly or bi-weekly papers were printed much of the local news was stale. A little more coverage was given in the thirties and forties, but only occasional copies of the papers of those decades have survived and the space devoted to local news was still small. A fair number of references have, however, been collected from these and other sources, sufficient to show that heavy flooding was by no means rare at this time. About 1850, when daily newspapers had become the rule, the practice of printing local news increased and from that time regular reports of floods are found. Most of these reports undoubtedly are somewhat exaggerated, but the exaggeration is rather in the general tone of the language used than in the particular details given. From these details it is possible to form some picture of what these early floods were like and to compare them with later floods which were more accurately recorded.

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* Department of Lands & Forests, Toronto; Survey Records, Field Notes, Vol. XV, p. 357; Letter of Mahlon Burwell, dated July 21, 1826, & Plan A41, London, June 29, 1826. In the plan the south and west banks of the river are only sketched in and are drawn rather inaccurately, the high ground south-west of the fork is placed too far south. This error led Burwell to recommend a bridge at Bathurst Street instead of York Street, as he intended and where the bridge was actually built.

1790-1849

The first direct reference that has been found to a flood on the Thames is contained in the field notes of Patrick McNiff, who had completed a survey of the lower part of the river. He reports that on April 18 he found, at the point just below Moraviantown where he ended his survey, "that the water had been Twenty feet above its then height." It was even then running eight feet deep at that point, with an eight-knot current, although he was told that a loaded canoe could hardly pass in the dry season. This would mean a rise of about 25 feet or more. McNiff adds that he was told that the flats from the end of his survey to "the second village of Delaware"* (near Muncey) "are at times overflowed."

The flood of 1791 would thus appear to have been severe and that of the spring of 1792 was probably nearly as high. Evidence of this flood and a detailed record of the behaviour of the river from 1792 to 1798 are to be found in the records of the Moravian Mission at Old Fairfield or "Schonfeldt" on the Thames opposite Moraviantown (New Fairfield). This village was built for Christian Delaware Indians driven out of their homes in Ohio by the Americans. While still at Detroit, before they had even visited the Thames, the Moravian Brothers were told by Indians that the spring freshets were formidable. When they moved up the river to look for a village site they found plain signs of recent flood. Going beyond all settlement, they found the current too strong for their heavy boat and had to make use of the canoes of some local Indians. They spent the next few days exploring the river. As they had come from the Muskingum, they were on the lookout for signs of flood and on April 27 they note that "along the river there is abundance

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*. There were two "Delaware" villages above Moraviantown, the first near Middlemiss and the second (the "Delaware Castle) on high ground near Muncey. They were both occupied by Munceys or Monseys, a tribe of the Delaware Nation. The Munceys were usually called Delawares by the English at this time. Zeisberger, however, always distinguishes between the "heathen" Munceys and his Christian Delawares. There was no white village of Delaware at this date.

of good and fine land, only in the spring it is flooded." In the entry of the 28th they are more definite: "We found out and saw that in the spring the river rises twenty feet or more, therefore all the bottoms are covered." Zeisberger evidently concluded that this was a yearly occurrence, which proved to be a mistake. A rise of twenty feet in the region between Moraviantown and Muncey indicates a pretty severe flood, such as comes only once or twice in ten years.

The Brothers chose a site for their village, taking care to place it out of reach of such floods. This was at first a little higher up the river than the site finally occupied, but at the final site also, care was taken to choose a situation on the higher terrace, near a spring creek. On May 1 - "In the forenoon we visited the country farther up and found good enough planting-land though wild, but no place for a town, since the places either go under water or are very high hills on the river." After they were finally settled at Old Fairfield, the Brothers continued to report the movements of the river (often calling it "the creek"). On May 17 after three days rain, "the creek rises fast" - the context makes it plain that the river is meant. Again on June the 9th, "from the very hard rains the river rose very much so that it is very muddy. It is therefore a fine thing that we have a good spring nearby, back of the town."

In the diary of 1793 is found a pattern of weather conditions which is to become familiar later on, A mid-January thaw melted the snow but caused no freshet. On March 16 - "For two days it has rained. The river rose high." By the 19th, the river had "so been rising for several days that it has overflowed the lowland and many fields." The height of the rise is not given so it was probably considerably less than the year before. On November 6, after several days of rain, "the river is risen very high" but no flooding is recorded. Governor Simcoe's party encountered the beginning of the March freshet of 1793 on the upper waters of the Thames near Woodstock, while returning from Detroit.

If 1793 was a fairly normal year, 1794 was exceptional in several ways. The river had not frozen by February 2. The "severest cold of the winter" came at the beginning of March when the thermometer stood at 19 degrees. By March 11, it was "fine and spring like", and thé temperature 70 degrees and "the ice broke up on the river". Three days later "the river ran strong with ice, coming from far up, and has risen very high." This sounds as though there may have been an ice block somewhare upstream, but, as was to be expected after a mild winter, no flooding at Fairfield is recorded.

Lower down the river, on MacGregor Creek, this freshet of March 1794 destroyed the dam and damaged the foundation of MacGregor's mill, not far from the site of Chatham. At the end of the month Colonel Simcoe took advantage of the high water and swift current to descend the river from Woodstock in a boat.

The sudden heat spoiled the run of sap, so that little sugar could be made. The summer was very hot. The thermometer stood at 96 degrees for "several days" at the end of July, "which it never has before." On November 23 a man came down from the new white settlement at Delaware which had been begun that summer, "with a raft of timber though drift ice was already running."

The year 1795 began with severe cold in January followed by "a thaw with rain" on January 29. Again cold set in and it was not till March 23 that "on account of the rain that fell last night the river broke up, when before there had been continued cold." "The first thunderstorm of this spring" came on March 25, "whereupon the river rose very much", but it turned cold again at once and there was no flooding of consequence. That autumn, however, was wet. On October 15 there was thunder all day and such high winds that roofs were blown off the buildings, and many trees fell. On Sunday, October 18, we find the following entry: "Michael preached,

and as it has been rainy the whole week, so that the river was unusually high, and the corn of several brethren under water, they helped one another to save it, whereby all were busy who were able, and so they continued to do the next day, for the water was all the time rising." They were more fortunate than the Munceys for, on the 25th, they "heard from the Munsey town, that in the high water their cornfields had been quite overflowed." During the winter the Delawares had to help the Munceys with gifts of corn to keep them from starving.

In 1796 there were no floods and the usual note that "the river is very high" is not found after the breakup. This would seem to have been due to partial thaws, followed in each case by cold weather, so that the snow melted gradually. There was some rain in March, but not so much as in former years. No autumn freshet took place.

The breakup of 1797 came on March the 16th.* The next day "on account of the high water many pine timber saw-blocks came down the river, many of which our Indians secured." This shows that Allen's sawmill yard at Delaware had been flooded. On March 31, "After the high river had fallen, the snow having melted, hard rains came in and it rose again." Many rafts "of pine lumber" went by in April and the beginning of May, and on May 3 the Brothers "bought some pine boards." Then the references to rafts cease for that year, perhaps because the water became too low to be convenient for rafting.

The little spring-fed "brook", "back of the town", had been giving trouble by icing over its banks and undermining the steep side of its ravine. Governor Simcoe and his suite had had difficulty in crossing on his first visit and

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* George Parrin Lawe notes a flood on the South Branch between March 14 and 16, 1797, in his diary of the Survey of Blandford. Lands and Forests Survey Records - Field Notes; Vol. III, p. 121.

both the brethren and travellers on the "road" from Niagara to Detroit were finding it a great inconvenience. The Brothers decided to bridge the ravine and got out timber for the bridge on January 13. They did not have time to begin work until July 24. In the meantime the stream had again cut into the bank. The bridge was finished on August 1, and the entry for that day remarks on the convenience it will be to the travellers as it is in "the road to Niagara." "Thunderstorms and rain pours" during the week of August 10 to 17 raised the brook and damaged the new bridge so that it had to be repaired, which was done on September 2.

In 1798 the sap was running on February 3rd. Most of January had been fine and mild. From February 19 till near the end of March, there was cold and heavy snow. On the twenty-seventh "the river broke up, with warm weather and high water." The next day "a party of whites went up to the Pinery to send timber rafts down." The high water continued for some days. On April 3 the water was "higher than it has ever been here and we hear that the snow above us, only three days ago, was knee-deep and therefore the river will still rise, when it has already come up more than 20 feet." This further rise may not have occurred, as Zeisberger does not mention the flood again. Severe cold and snow "as at Christmas" came on the 16th. On the 20th, there were "lightening and downpours of rain", which probably brought the river up somewhat, for rafting began the next day and went on all week.

Zeisberger's diary ends in 1798 and for the next twenty or thirty years our information about the river's movements is scanty and there are few detailed flood references.

Even if such references had been found, it would be unnecessary to deal with them in detail, for it is probable that each decade in which several severe floods occurred conformed fairly closely to the pattern of the 1790's. The types of flood that later become familiar are found in this

first recorded group; the flood of peak severity, like that of 1791, followed (and probably preceded) by others of slightly less height; the moderate freshets intervening between these and causing little or no flooding; the rare gale or twister combined with a thunderstorm in autumn or early winter sometimes producing severe floods as well as wind damage when it follows prolonged wet weather; and the sudden spate after a summer "cloudburst" usually causing only slight damage as in this case, but when the ground is already sodden producing the most dangerous and damaging type of flood. The reports of the weather, interesting in themselves, show very clearly the conditions that produce flooding or check it after it has begun, and, in spite of the small amount of settlement on the river, typical examples of flood damage are recorded. These early reports differ from those found after 1850 chiefly in the absence of direct mention of ice jams and in the longer duration of the high water.

The use to which the inhabitants put the freshets during the first fifty years of settlement is well illustrated by the references to rafting and by Simcoe's second trip down the river. The periodic swelling of the rivers and streams played a large part in the life of these settlers on the Thames, as it did elsewhere in the Canadian bush. George Heriot, in his "Travels Through Canada, 1807," has an interesting passage on this subject. Speaking of the advantages enjoyed by the farmers along the St. Lawrence, who could ship their produce to market on rafts at any season, he writes: "on all other rivers except those of the first magnitude, they who mean to conduct rafts down their stream are compelled to be ready at the moment of a swell of the waters"; otherwise they might have to wait for a whole year. He also says that it sometimes happened that the "spring freshets are not sufficiently high" for rafting. This had occurred on the Thames in 1806, when the lumber was piled up in the yards of the sawmills at Delaware and at

Dorchester waiting for enough water to raft it to Detroit.

"High water" on the South Branch, lasting from April 3 to April 9, interrupted William Hambly's survey of lots on Dundas Street (Governor's Road) in 1800. Hambly also records finding a great flood on the Lower Thames and all the low ground under water when returning from a survey near the Sydenham River on September 13, 1804. Nathan Bangs, the first Methodist circuit rider to visit the Thames settlements, mentions encountering heavy flooding a little higher up the river in October and November of the same year.* It is not certain whether any other floods occurred on the Thames in this decade. Plain signs of flooding, that had covered the North Branch flats in the second Concession of London Township to the depth of three feet or more, were observed in the summer of 1810 and it is likely that this flood had been fairly recent.

Between 1810 and 1830 only one definite reference to floods has yet been found, though there are several general references to the "periodic inundation" or "annual overflowing" of the flats. When this was of normal extent it was considered an advantage because it enriched the meadows with silt. It is likely that one or two heavy floods occurred during the war of 1812-15, for flood damage is reported from other rivers. Floods on Springer's Creek and the Medway in 1819 interfered with Mahlon Burwell's survey of Lobo or with his journeys to and from that township. A series of mild years after 1822, with dry summers and open winters, caused a shortage of water in South-western Ontario so that swamps and streams dried up and mills could not grind. It is not likely that there were other serious floods before 1829, though there are some references to high water. After 1826 the population of the

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* The flood in September brought down a quantity of driftwood and was probably severe over the whole watershed, for severe floods occurred at the same time on rivers near Toronto.

area was growing; traffic was increasing on the roads; bridges and mills were built and towns laid out. Flood damage became more important and was more often reported.

In 1830, "the London stocks which had fallen into disfavour as a punishment, were formally committed to the Thames in spring flood" by the constable. "The London Bridge was broken" in the late summer of that year probably as a result of the flood. Other references to floods at about this time are not uncommon in the diaries and reminiscences of the early inhabitants of London. We are told that this bridge at the foot of York Street (built in 1826) was chained to some large trees "to prevent it being floated away in the spring floods". Samual Strickland, speaking of his visit to Chatham in 1832, remarks that the flats on either side of the river for the first ten miles from its mouth were usually flooded in the spring.

The milldam built by the Canada Company at Stratford in 1832 was damaged several times by floods before it was finally completed at "enormous" cost late in 1837. One of these floods took place in 1833, when there is evidence of flooding on streams near Komoka. Another was the flood of 1836 by which the bridge at Chatham was destroyed and "the bridge over Rhode's milldam was carried away" before April 9, when the Reverend John Proudfoot attempted to cross it. The stream was evidently too deep to ford on horseback and the Presbyterian minister of London was not accustomed to "swimming his horse through the swollen streams" as the Reverend Mr. Cronyn was in the habit of doing at this time. The flood of 1837 damaged bridges in the London District and possibly also the dam at Stratford.

The rebuilt bridge at Chatham was again damaged in 1841 and in 1843 damage to the Delaware and Kilworth Bridges is reported. The bridges must have been impassable, for on Easter Sunday (April 16), four members of a party of fourteen who tried to cross in a scow at Delaware were drowned when the

scow caught in the branches of a fallen tree and was swamped. At about the same date, a party of indignant citizens set out from London, bent on destroying "Gardiner Bros.' mill dam in Mosa", but finding the dam "partially destroyed by the flood and the water too high", they contented themselves with threats and marched off to the nearest taverns. This dam was unpopular with both lumbermen and fishermen because the chute provided did not allow rafts to pass at times when the river was high enough for rafting everywhere else and because the fish could only pass it "at the high floods".

The spring flood of 1846 appears to have been long and severe. Marcus Gunn records in his diary for March 13, "Great Waters pass in the rivers." On the 26th, he says, "The rivers appear occupied with magnificent Waters." He uses almost exactly the same words to describe the flood of 1852 so that this flood was probably of about the same degree of severity. It is not till April 4th that Gunn notes that "the rivers are now much fallen". On January 2, 1847, he writes, "the river is much swollen with waters" and on January 12, "the river appears filled with ice and the waters accumulate and overflow." On April 4, 1847, Gunn records mild weather and a thunderstorm. The next two days were "mild and springlike", and on the 8th: "The River exhibits great elevation of waters reducing its banks in our vicinity". On the 9th: "The waters of the River are still more elevated today", and on the 10th: "The Rivers are still overflowing with water". Gunn's language is somewhat ambiguous but there can be no doubt that these were floods of impressive size.

It is stated that the bridges in London and its neighbourhood, before 1849 "were constructed of wood and frequently destroyed by the spring floods." It would not need a very severe freshet to damage some of the bridges of that time. An attempt to raise the bridge above the height of the floods seems to have been made in some instances. The building of

more mill dams and bridges in the forties probably helped to increase the severity of floods, by causing ice jams in the river.

1851-1879

When detailed reports of floods begin to appear in the newspapers after 1849, ice jams and damage from ice are often reported. This was the case in March, 1851, when three days of rain "with the snow in the bush" made the Thames "burst all bounds". A block formed at Shepherd's mill dam on the South Branch, and when it broke the ice swept downstream at "eight or ten miles per hour". Shepherd's bridge escaped, but the bridge at the foot of Ridout Street (built 1849) was damaged and most of the bridges downstream were broken. Blackfriars Bridge may also have been damaged in 1851, for it is referred to as "new Blackfriars bridge" in the account of the freshet of 1852, which it withstood successfully. This latter flood took out the bridge on the Hamilton road, interrupting the post for three days, and also damaged "most of the mill dams".

A bursting mill dam ("Benson's") at Ingersoll was responsible in 1856 for a flood that destroyed buildings and bridges, doing $5,000 damage.* At London "Hunt's new mill dam" was destroyed and Clarke's Bridge damaged.

This bridge (built first in 1841) was wrecked in the spring flood of 1857, which seems to have been universally severe. The thaw took place on February 6 and 7 and the water in the neighbourhood of Clarke's Bridge was eleven feet or more above "the normal level". "A house close by was entirely filled with water" - the first mention of houses being flooded at London. The Avon flooded cellars at Stratford and destroyed a quantity of wheat. This flood did a great deal of

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* This was probably the same dam on the creek that caused damage in several other years. In 1887 a house was washed away and four people drowned.

damage at Delaware and at Chatham. Ice, "up-rooted trees and saw logs" took out the Kilworth Bridge and with it a farmer, named William Oxterly, who was on it at the time. He was reported to be drowned, but later it was learned that he had "saved himself by making a raft of driftwood". There was a second rise in the river at Chatham on February 17, which may represent the freshet on the North Branch. This branch flooded on its upper waters in 1858, doing damage from Mitchell to St. Marys and submerging the latter village sufficiently for the editor of the St. Marys Argus to suggest the erection of a "breast work" to protect the low ground.

The flood of 1861 caused more loss and attracted more attention than that of 1857 because the low ground in the towns was by then more built up than four years before. This time a number of houses around Clarke's Bridge were flooded and the occupants taken off in boats. The water here may not have been much higher than in 1857. The ice passed under the rebuilt bridge, but tore off some of the iron plates with which the piers had been strengthened. The North Branch flooded parts of St. Marys, forcing "people near the woollen factory" to leave their houses, wading through "three or four feet of water" and "with their wanes on their backs". Roads and bridges were damaged between St. Marys and London, and Kilworth Bridge was "finally carried away".

In March 1865, and again in February 1867, the river rose "above its ordinary (spring) level of ten to twelve feet". In 1865 besides the South Branch flats, the low ground "at the foot of Dundas Street" was flooded to the imminent danger of Constable Phair's livestock, which were rescued just in time, the water being then four feet deep in his kitchen and stable. Several bridges suffered as they did again in 1867. This led the London Free Press to critize the short-sighted policy of building cheap bridges which were swept away in every flood. The Free Press also comments on the loss to farmers in

fences and "out buildings" and remarks that "everything left near the river's bank in the village, is from year to year invariably swept off for the benefit of the people westward".

The flood of 1868 was one of the very severe floods on the Thames. The damage on the Upper Watershed was heavy, especially on the North Branch from Mitchell down. There was a flood on Trout Creek and three people were drowned in the neighbourhood of Fullarton. But it was the lower part of the river valley that suffered most. This was due to a huge blockade of ice and debris at the river's mouth. The type of driftwood in this block indicates the amount of lumbering on the upper waters. It included great quantities of "cordwood, timber (squared), staves and brushwood". The block formed on March 13, after the first freshet had passed, and it backed up the waters so as to flood much of Chatham "four or five feet deep". Miles of country around were covered several feet deep. Vessels were washed from their moorings and railway traffic was interrupted for days. The water in Chatham was about eighteen feet "above the summer level and two feet above high water mark of last year". This flood was considered at Chatham "by far the greatest . . . in thirty years". It was not to be equalled there for thirty years more.

A summer freshet on the Thames occurred on July 25, 1869, on the North Branch. It reached flood proportions in the Stratford area, and below St. Marys a farmer narrowly escaped drowning when he was washed away in his waggon. He was saved by a log-boom in the river, but his team was drowned.

The more serious floods of the 1870's all occurred between January 24, 1873, and January 24, 1874. The spring freshet of 1873 flooded the London flats "from the cove bridge to the foot of Dundas Street". On the Kensington (West London) flats, which were just beginning to be occupied, the water was ten feet deep in places for "forty hours" and

"four hundred feet wide on its narrowest side." Thamesville and Chatham were heavily flooded and the railway bridge at Chatham was washed out, along with many other bridges and mill dams. Floods and flood damage are reported from Mitchell, St. Marys, Stratford, Woodstock, and other places.

On December 4, 1873, a furious storm spread destruction over the country and floods occurred on several rivers. The flooding on the Thames, however, was not entirely due to this "hurricane". There had been sleighing in November, but a thaw began and heavy rain fell on the northern part of the watershed from the 1st to the 3rd of December. The North Branch and its tributaries were already flooding by the 3rd and doing damage at Stratford and Mitchell. When the "twister" struck there was heavy wind damage and more serious flooding.

At London the wind wrecked a number of buildings and "to add to the seriousness of the situation, the river already swollen by the thaw, overflowed and again flooded the flats". The river was "a foot higher than during the great freshet in the spring", and was thought to be "higher than ever before". At Chatham the water rose "about three feet above the docks" and flooded part of the town. The merchants had time to remove their goods from cellars and warehouses and the loss was not so great as in the spring.

The flood of January 23, 1874, was the highest of the three. Kensington was flooded to a greater extent than ever before and "all the suburbs . . . bordering on the low ground, that never before were visited by flood are partially submerged". Chatham and Thamesville suffered again. A railway accident was caused by a washout at Thamesville. Two miles of the Great Western Railway track, west of Chatham, were under water and all traffic stopped for some days.

The great quantity of "brushwood, timbers, staves and sawn lumber as well as saw logs" which came down with this flood is an indication of its extent on the upper watershed.

They also show that the lumbermen were busy and that the forest was fast disappearing. From 1868 till well into the '80's this type of flotsam caused a good part of the flood damage, either directly or by forming blocks which raised the height of the water. After 1885 it is seldom mentioned.

This "immense series of freshets" roused the inhabitants of the "newly erected" houses in Kensington to the risks of their situation. The river was anxiously watched each spring for some years. In 1875 it was twice reported to the Toronto Globe that the freshet had passed and "all danger of flood was at an end". On April 1 the river rose a third time and flooded parts of Kensington before it returned to its "normal height for the season".

<u>1880-1899</u>

The next eight years, however, produced only sharp freshets and local floods, mostly on the North Branch. Three of these occurred in the spring of 1881. First the ice on the North Branch went out on February 12, "with a tremendous roar", threatening to flood Kensington. The threat was repeated two days later when a jam formed above London, but it passed without doing damage. Then, in March, St. Marys was partly flooded and the water rose thirteen feet at Chatham, flooding the lower ground. Again in April, Trout Creek and the Thames were "very high" and some further flooding occurred - three freshets in as many months.

March of 1883 saw Kensington again "completely flooded" and the boats again busy rescuing the inhabitants. The damage to roads and bridges in London Township was estimated at five thousand dollars.* But, though the spring flood was severe enough, it was completely overshadowed by the catastrophe of July 10 - 11, 1883. All future floods were compared to that

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* Possibly equal to $15,000 in modern money. The "annual average damage", between 1925 and 1950, was given as $6,000 in this township.

of 1883 and it was many years before any could be said to have equalled it in severity.

The immediate cause of this disaster was an electric storm which moved over part of the watershed in a wide circle, with its centre near London. The ground was already soaked by heavy rains and the creeks and rivers swollen to an unusual height. There had been flooding in several places and washouts had caused railway accidents along the South Branch a few days before. The Thames was very high on the 9th of July, but it dropped considerably on the 10th. That night, a little before midnight, the storm broke and three inches of rain fell in three hours. At three a.m. on the 11th, a "wall of water" swept down on Kensington from the north, washing many houses from their foundations and carrying them downstream to be crushed in some cases against the bridges. There was no warning in Kensington, though the storm had roused many from their sleep. People were drowned in their houses or trying to reach higher ground and one child was crushed by the fragments of its home as it was being handed to its mother who had taken refuge in a tree. The few two-story houses mostly stood firm, one giving shelter to fifty people. The loss of life might have been greater if boats had not been got out at once to take people to safety. The London fire-bells rang for hours, so that when the South Branch rose, later in the morning, the alarm had already been given. No lives were lost in that quarter, although six acres of land disappeared completely from above Clarke's Bridge, leaving only a bed of fresh gravel. With the soil went five houses, their stables and sheds and all their contents. The other flats on this branch were swept also. Eighteen people were killed in all, including several children, and a great number lost all their possessions. The flats downstream were strewn with trunks, furniture and the wreckage of houses.


From "Illustrated London", 1897

London West from the Court House, July, 1883.


Detroit News Pictur

London West from the foot of Carling Street, April, 1937.

Thunderstorms in Logan Township and near Fullarton on the 12th must have prolonged the flood at London. The North Branch flooded flats in that area, destroying fences and hay. Otherwise the area of destruction did not extend much above Thorndale on the North Branch or above Ingersoll on the South Branch. At Thorndale the mill dam burst and some houses and a church were moved from their foundations. The bridges from Springbank to Delaware were broken by the steamship Princess Louise,* as it was swept down to the Delaware flats, where it came to rest a complete wreck. Crops on the flats were damaged as far down as Chatham. At Chatham the debris broke the railway bridge, but the flooding in the town was not as serious as in 1868.

It was the unexpected and appalling force of this spate that distinguished it from all others. The height of water on the South Branch (13 feet) had been equalled by former floods. On the North Branch the height was greater, since it was swollen by the contents of mill dams at Thorndale and elsewhere. The height over the waterworks dam at Springbank (12 feet 11 inches) was to remain the highest for fifty years or more.

There was another sudden and heavy flood at Mitchell on August 19, 1883, caused by the same storm that produced severe floods on the Nith and other rivers. But this storm missed most of the watershed and was not felt at Stratford and St. Marys.

After such a catastrophe it is not surprising to learn that some families abandoned Kensington altogether. That autumn the suburb was reported (probably with some exaggeration) to be half deserted. But it has always been

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* One of two pleasure boats of some size, plying between London and Springbank Park on the reach of deep water formed by the waterwork dam. These steamers are mentioned in the accounts of some later floods.

found impossible to abandon a site, once it has been occupied as a town, and the remainder of the population of Kensington preferred to organize measures of protection rather than to abandon their property. They were kept on the alert from February 20 to March 21, 1885, by an ice jam in the river which caused slight floods on both branches. Some families moved out with their furniture but in the end the ice went out without more flooding.

Public meetings were called and the London Waterworks dam was fixed upon as a scapegoat. Threats to destroy it were uttered and this issue was not settled for some years. In the meantime a dike of earth and timber was erected on the west bank of the North Branch and for some distance below the forks, in the autumn of 1885. The river had again flooded part of Kensington in the previous April. The dike or "break water" was finished by winter and withstood the freshet of 1886 fairly well. Some of the new fill collapsed and the baseball ground was flooded; but between 1886 and 1893, the dike protected West London from three freshets, all of which did damage elsewhere.

Another of the very severe floods on the Thames took place in 1898. This flood was heavy on both branches; St. Marys was flooded "to a greater degree than in many previous years". All the flats on the South Branch were under water. West London was not seriously threatened at first, though the embankment was leaking and people were warned to leave. They were slow in doing so, as it was fifteen years since the great flood and the water was rising slowly. After a sharp rise occurred on March 13 , eighty feet of the dyke suddenly collapsed. The water rushed in with great force, cutting off those who had delayed in their houses, dispersing a large crowd of onlookers, and forcing the Mayor to scramble onto the roof of the carriage in which he was driving. No lives were lost, and in fact, no one was in danger. Boats took off the people

From "Illustrated London", 1897

London West from Kent Street, showing flood dyke, 1897. The dam in the foreground must have increased the tendency to ice jams.

Carty News Service, London, Canada

London West Breakwater from Blackfriars Bridge, 1945.

who were still in their houses, and the interiors of the houses were a good deal damaged by water. The flood was the highest since 1883. The reports in some Toronto papers were so exaggerated that the local patriotism of the Londoners was aroused and from this date a tendency to minimize the flood nuisance is noticeable.

As in 1868, this flood was much more severe at Chatham than elsewhere. There had been very heavy rain, but the ice on Lake St. Clair was still solid. These factors, combined with a strong west wind, raised the water at Chatham to about eighteen feet above normal (17 feet 4 inches on March 16). This was the worst flood in this area since 1868. Chatham was in darkness, as the power plant and the gas mains were flooded. A large part of the town was under water. "The country to the east" was flooded "for miles", as was all the low ground below the city. The loss in Chatham was put at $54,000. It is noted that the water was a "muddy yellow colour", the first time this is recorded since 1792, though probably not the first time it had occurred. The flood of 1899 was nearly as high as the year before but no special circumstances at London or Chatham aggravated its effects. The river rose "eleven feet in four hours", flooded the flats on the South Branch and broke the dam at Springbank. The West London dike was still "hard frozen," so that this suburb escaped.

1900-1919

In three of the first four years of this century heavy floods did damage in various parts of the watershed and caused anxiety at London. No serious damage occurred there, however, until the flood of March 1904. This proved to be one of the most severe. Most of the ice on the North Branch went out without doing any harm, but an ice jam at St. Marys broke at four-thirty p.m. on March 25. The flood came down the North Branch with "terrific speed". The South Branch broke up about the same time and by 11:00 p.m. the flood on this

Branch was "something tremendous". All the low ground in that section was flooded several feet deep. The breakwater protecting West London was patrolled all night. It was strengthened with sacks of sand and until after midnight it seemed to be holding. At 1:00 p.m. on March 26, "those people who had gone to rest (in West London) were awakened by a horseman galloping furiously through the streets shouting that the breakwater had given way". "Women deserted the houses . . . in five minutes", but the men "remained to place chairs under pianos" and take other steps to protect their goods. The water flowed over the dike as well as through the breaks. The baseball ground was soon under six feet of water. A young man, who had gone out in a canoe to help take people off from the houses, was upset and drowned. Ten feet six inches was the high mark over the Springbank dam - the highest since 1883. The flood started a fire at Woodstock by wetting lime in a shed at a furniture factory. Thamesville was completely flooded and at Chatham the flood was the highest since 1898.

The river dropped on the 28th, but the next day came reports that "up north the woods are full of snow and the ... creeks jammed with ice". The ground was still frozen, so another flood was expected. It came on April 1 and 2, the river rising twelve feet. The repaired dikes held and there were no serious consequences at London.

As a result of this series of floods, the dikes were lengthened and rebuilt in 1905. For the next twenty-five years, although other parts of London and of the watershed suffered several times, West London escaped with only some alarms of floods.

The floods between 1909 and 1929 were rendered more serious by ice jams that sometimes turned moderately heavy floods on the upper river into severe ones at Chatham and below. This happened in 1910, when a five-mile ice jam

at Prairie Siding backed up the water for three days and flooded the city and miles of the low ground. Farmers suffered heavily and there was serious damage to the railway, estimated at $40,000. The situation was very similar in 1912, 1916 and 1920, but in 1912 the flooding was more widespread on the upper watershed and below Chatham somewhat less so than in 1910.

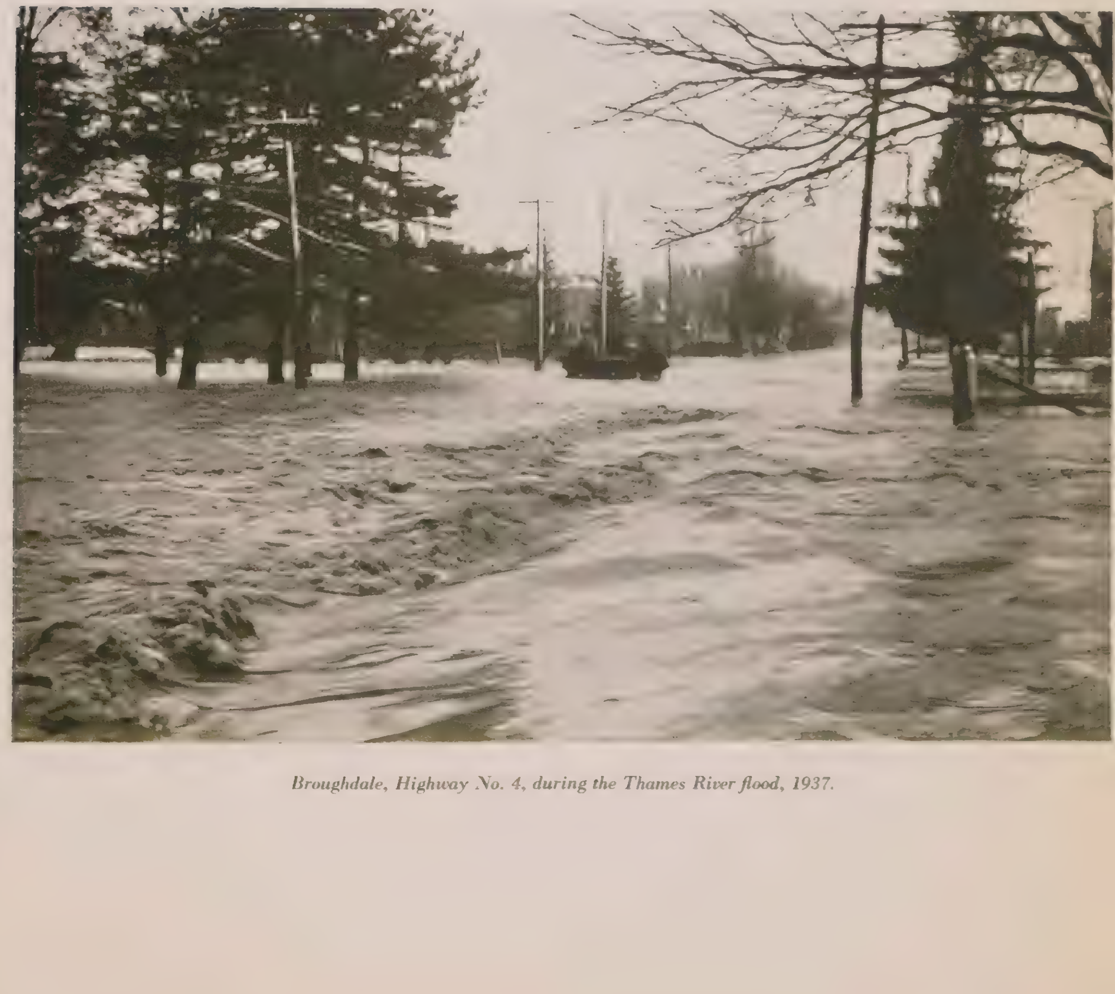
The breakup in 1912 was accompanied by heavy rains. The Thames was more than ten feet above normal at Chatham on April 1. On the 2nd, the river had risen to fifteen feet and the country above and below Chatham was flooded. An ice jam, two miles long, formed at Prairie Siding. By the fourth of April the water had reached 16 feet 7 inches above "high water mark" at Chatham, and wide stretches of country were under water from the river's mouth to above Kent Bridge. The flood was "the highest since 1904" and took some days to subside. Severe flooding on the North Branch caused serious damage in Mitchell, Stratford and St. Marys, forcing mills, factories and quarries to shut down and sweeping away dams and bridges over much of Perth County. A severe flood was expected in London, but the damage there was not serious.

The North Branch flooded again in the following January, doing serious damage near St. Marys and causing ice jams above Broughdale. The March flood of 1913, however, was most serious on the South Branch, especially near Ingersoll. The southern flats at London were not protected by dikes and were badly flooded. The waterworks dam at Springbank broke on March 30 as the result of the freshets.

Again in 1918, the floods covered parts of London not protected by the main dike. The flooding was chiefly along the South Branch, where the river flooded the gasworks and put out a fire which had burned for five weeks under the C.P.R. tracks.

Photo by F. A. Campbell

Mitchell—*1912. Looking Southeast from near the dam.*



Broughdale, Highway No. 4, during the Thames River flood, 1937.

1920-1939

The heavy flood of 1929 was chiefly felt in North London which was growing into a populous suburb. There was a serious ice jam on the North Branch in that neighbourhood. The water was said to be higher there than at any time since 1883. The West London Dike was pierced near Douglas Avenue, but it was quickly repaired and little harm was done.

In 1930 the water in the Thames was above normal height through most of January and February. The mean discharges for both months were exceptionally high and, though no very unusual peaks were reached on either branch, several freshets occurred. Ice conditions turned some of these into severe or heavy floods above Chatham. There was flooding at Woodstock on January 8, The river rose and fell several times in the following weeks without serious flooding. It was rising once more at Chatham on February 21, but it was not till February 23 that heavy flooding took place at Stratford, St. Marys and Ingersoll, and on the unprotected flats at London. This flood was over on the upper part of both branches by the 25th, but at London both branches were still rising six inches an hour. Thamesville was now completely cut off from any form of communication except by telephone, and there was four feet of water on Highway No. 2 in that vicinity. At Chatham the flood was thought to be "possibly the highest since 1904". The slow rise had reduced the damage in that city and below Chatham the flooding was not increased by ice jams.

In March 1935 heavy freshets on both branches caused a rise of 17 feet at the Douglas Avenue gauge in London, but because there was little ice no serious flooding occurred. In 1936 an ice jam at Prairie Siding again turned a moderate freshet into a serious flood below Chatham, but on the whole the Thames Watershed suffered less than the rest of the Province in 1936.

The great flood that visited the Thames Watershed on April 26-30, 1937, still remains the highest on record and, as regards destruction of property, is probably the most severe since the watershed was settled. It was caused by heavy and prolonged rains. The snow had melted completely and it is believed that the frost was out of the ground. A flood after the first thaw has melted the snow is not uncommon on the Thames. The two most disastrous floods since 1800 took place without snow to increase the run-off, when the ground, though sodden, was not frozen and when the river was free from ice.

The rainfall at London up to April 21 had been only slightly above normal for the district. But during the next week 5.48 inches of rain fell at London as against a normal or average rainfall of .56 inches, an excess of almost five inches above normal. The following table shows the daily rainfall and temperatures at London from April 21 to April 27, 1937.

PRECIPITATION AND TEMPERATURE
AT LONDON, APRIL 21-27, 1937

Date	Precipitation			Temperature	
	Inches	Total from April 1	Normal Total from April 1	High	Low
April 21	-	2.26	1.86	54	38
April 22	1.40	3.66	1.9[illegible]	40	42
April 23	.04	3.70	2.0[illegible]	[illegible]	34
April 24	-	3.70	2.14	48	36
April 25	.20	3.90			
April 26	1.82	5.72	2.32	46	38
April 27	2.02	7.74	2.42	40	32

These figures indicate the general conditions for the upper watershed, but it should be added that the general average for South-western Ontario was 5.48 inches for the period - identical with that of London.

Detroit News Airphoto

South Branch flats during the flood of April, 1937.

Detroit News Picture

Part of West London, Ontario, during the flood of the Thames River, April, 1937.

The flood at London began on April 26, when the North Branch rose 15 feet at Fanshawe in a few hours. The flats on this branch, with the suburb of Broughdale and a part of North London, were all flooded. At Broughdale the water was running over the highway on both sides of the bridge, more than 18 inches deep and with a strong current. The flood overtopped the West London dikes, spreading over a wider area than in any flood since the dikes had been rebuilt in 1905. The depth of water in West London, however, does not appear to have been as great as in some past floods, possibly because the dikes kept more water in the bed of the river. Depths of about ten feet over considerable areas and lasting for some time are reported in December 1873 and July 1883. While there may be some exaggeration in these reports, nothing approaching this was reported in 1937 and figures of the height of water at Walnut Street and Wharncliffe Road at similar stages of the floods of 1888, 1904 and 1937 confirm the impression that the water in 1937 was less deep within the dike. The lower depth limited the danger but hardly reduced the loss and inconvenience. The North Branch fell quickly, going down more than two feet before midnight of the 26th.

In the meantime the South Branch had risen 13 feet 9 inches at Ealing, and continued to rise for some hours after the North Branch had fallen. During the morning of April 27 it reached the record height of 21 feet 6 inches above mean summer flow at Ealing, continuing at nearly the same height till afternoon. Because the high ground is closer to the river on the South Branch, the areas flooded there in 1937 were much the same as in former floods, but the water in many places was deeper than in West London.

At the Douglas Avenue gauge, just below the confluence, the combined floods reached 17.19 feet above the bottom of the gauge, or about 23 feet above "normal summer level with the Springbank dam closed" (slightly lower than mean

summer flow). The maximum rise in July 1883 was said (in 1937) to have been "within three feet" of this and therefore over twenty feet. The height on the South Branch (at Wellington Street) in that flood was 13 feet above "normal flow" and the North Branch rose much higher than the South Branch. The heights reported "at London" in 1883 and in the floods of 1873-4 were probably measured fairly accurately at some fixed point, but since the height of "normal flow" is unknown, it is difficult to compare them to gauge readings made since 1928. In 1883 "normal" below the confluence was probably close to 752 feet above sea level, given as the present normal summer level with the Springbank dam closed, but before the dam was built in 1877 it may well have been somewhat lower. After 1877 the floods were usually measured by the height of water over the Springbank dam, making it still more difficult to make comparisons with gauge readings near the confluence. The height of the rise at Douglas Avenue in some floods between 1928 and 1938 is given below, with the rise in some earlier floods added for comparison, though these earlier figures can only be regarded as approximations.

Year	Douglas Avenue Gauge	Year	"At London"
1928	18.87 feet.	1873 (Apr.)	17 feet
		1873 (Dec.)	18 "
1935	16.98 "	1874 (Jan.)	over 18 "
1936	14.73 "		
1937	23.19 "	1883 (July)	" 20 "
1938	9.50 "		

Flood damage in London was very heavy. Nearly 8 per cent of the area of the city was flooded, 545 acres in all. The population of the flooded areas was 4,184 or 5.5 per cent of the total population of 76,424. By far the greater part of the 1,075 buildings affected were private houses, mostly of small or medium size. On 762 of these houses the City granted a reduction of 10 per cent of assessment,

a total reduction of $168,000. The total assessments in the flooded areas amounted to $2,582,635 - 3 per cent of the total assessment in the city. The 10 per cent reduction granted on more than 70 per cent of residential property was probably close to the average depreciation from flood in such cases, but in the case of the very few industrial properties flooded the depreciation was probably less in proportion to their much greater assessment. Even so the damage to real property and to buildings was probably more than $250,000. The amount of damage to the contents of the buildings and to other movable property is more difficult to estimate. It was certainly more than double the depreciation of real estate and the total private loss in London may be placed close to $800,000.

The damage to City property was also very heavy. The City Engineer's Department spent $94,400 as a direct result of the flood, exclusive of the damage to the Wellington Street Bridge and the cost of raising the dikes and building new ones on the South Branch. The Wellington Street Bridge was considered to be nearly obsolete and the damage was estimated at only $10,000. The bridge was rebuilt in 1938 at a cost of $108,655 so that this estimate of flood damage is possibly too low. More than $27,600 was expended on the dikes between 1937 and 1945, chiefly as a result of the flood of 1937.

Besides the actual damage to property the City had other expenses as a result of the flood. No estimate has been received of the amount expended by the City on direct relief. The Canadian Red Cross reports $222,425 spent in London and the vicinity in assisting flood sufferers and in rehabilitation. Most of the inhabitants of the flooded areas were temporarily homeless. Since the flood occurred in a time of business depression, many families were in no position to meet such a loss without help. No houses were destroyed and no loss of life is reported from London. The danger was lessened by the fact that the flood was at its worst during the day and that there was no sudden failure of the dikes.

Above—Wrecked House at Broughdale—
1937.

Right—Flooded Store in London—1947.

There was heavy damage to roads and bridges throughout the watershed above Thamesville. Oxford County spent $38,914 on repairing or replacing 12 bridges, besides $5,000 on fill. The cost to the Counties of Middlesex and Perth was not so great, but may be estimated at a total of between $10,000 and $15,000. Dorchester North, Oxford West, Nissouri West and Downie Townships report items of damage to bridges ranging from $500 to $3,000 and totalling $7,500. The damage in London Township was probably more serious than in any of these and may have approached the total figure for the four. The remaining townships suffered less severely.

Most of the towns in the Upper Watershed are so situated that they are little exposed to floods on the main streams. In almost every case, except at St. Marys, the greater part of the damage was done by smaller creeks. Even at St. Marys a large part of the loss was caused by the flooding of Trout Creek. The Canadian Pacific Railway line was damaged below the junction of the two streams. The damage to public property in St. Marys was estimated at $1,500.

At Stratford the flood on the Avon washed out the dam of the lake in the centre of the town, causing $1,500 damage. The damage to private property was chiefly caused by Erie Creek, a small stream, now flowing underground through part of the town. The culvert on this stream was blocked by debris and the water backed up and spread over a low area near the centre of the city.

Woodstock suffered $800 damage to public property. The private loss was estimated at not more than $1,200 , but this estimate is possibly too low. Here again it was the flooding of Cedar Creek which caused most damage. Various industries are situated along Cedar Creek and some public park lands there were flooded. Only a small amount of residential property was affected.

The milldam and the highway bridge at Thamesford were injured and a dam at Embro was broken. This is one of the very few definite records of flood damage on the Middle Branch. Floods have occurred on this branch at various times, but owing to local conditions they did less damage than elsewhere and there is much less information available regarding these floods.

The Canadian National Railway line between Woodstock and Ingersoll was inundated and a washout wrecked a train and interrupted traffic for a considerable time. The quarries near Beachville were flooded and very large estimates have been received of the damage here and to the industrial plants near Ingersoll. In Ingersoll the factories near the river were the chief sufferers and the damage to private property within the limits was estimated soon after the flood at $25,000. This estimate was possibly over-optimistic. Damage to public property in Ingersoll was placed at $10,000, without reckoning the cost of the bridge, which was considered to be obsolete. The replacement of this bridge cost the town $27,000 and the Ontario Department of Highways spent $4,000 on a temporary bridge. Some part of the cost of the bridge should be added to flood costs.

Below London the flats were all flooded more or less. The whole village of Thamesville was overflowed and all access cut off except by boat and the Canadian National Railway right-of-way. Public property was damaged to the extent of $1,000. The Red Cross Society spent some $1,182 for rehabilitation in the village and vicinity.

The flood took sixty hours to travel from London to Chatham, compared with about seventy-two hours in 1865. The flood crests reached Chatham on the 29th and 30th of April, so that the city had some warning in advance that a severe flood might be expected. The rainfall at Chatham had been only about two inches as against nearly six inches in London.

This fact may have led the inhabitants of Chatham to underestimate the probable height of the flood. Otherwise, it would have been possible to reduce the amount of loss by removing more of the threatened property.

The peak elevation of the flood at Chatham was 19 feet 8 inches in 1937. In 1868 it reached approximately 19 feet and in 1898 about 18 feet. The latter figures appear to be definite measurements like those taken at Springbank after 1877, and not merely estimates as are all the early elevations given at London. Nevertheless it is not possible to make accurate comparisons with the records of the flood of 1937. Local conditions have changed too much in the interval. Taking into consideration, however, all the available information, it would appear that the flood of 1937 did not surpass all its predecessors to quite the extent that has been believed, except as regards the amount of damage to property.

No figures have been received for the expense resulting from railway washouts in the Thames area in 1937 or from interruption of traffic. It was not possible to isolate expenses resulting from the flooding of Provincial highways, with the consequent extra patrolling and rerouting of traffic; the temporary bridge at Ingersoll was the only item reported. The Hydro-Electric Power Commission report $100,000 damage to their property in the London division. Some part of this occurred outside the Thames Watershed, but the damage caused by the Thames and its tributaries may perhaps account for 50-60 per cent of this total.

The total expenditures of the Red Cross on relief and rehabilitation are given as follows:

London and vicinity	$222,425.00
Thamesville and vicinity	1,182.55
Chatham and vicinity	4,320.40
Stratford and vicinity	85.00
Total	$228,012.95

Flooded bottom land along the Thames, May 19th, 1945.

Cattle marooned by the flooded Thames, May 17th, 1945.

From the information available the cost of damage to public property of various kinds may be conservatively estimated at more than $350,000, without reckoning the damage to railway property. The damage to private property cannot be easily estimated, but in the cities, towns and villages and their immediate vicinity it would appear to have been in the neighbourhood of $1,250,000. When the cost of the damage to farm property and the sums expended on relief and incidental expenses are added, the total cost of the flood of 1937 can have been little short of $2,000,000.

The next two years produced no serious flooding, but in April, 1940, the river twice rose 15 feet above summer flow at Douglas Avenue in London. On the night of April 8-9, St. Marys was flooded almost as seriously as in 1937. Most of the stores in the business section suffered, but precautions reduced the damage to some extent. The ice had not yet gone out at Mitchell and this second rise caused alarm at London. Families moved out of London West and firemen were alerted for rescue work. Parts of Adelaide Street and of No. 4 Highway were under water. The ice did some damage at Mitchell, but elsewhere the expected rise did not take place and flooding on the rest of the watershed was not exceptional.

The spring floods of the next seven years were not remarkable, though the sudden rise on the North Branch in March, 1943, caused alarm in Broughdale and West London and did some damage to the Breakwater. In 1941 the freshet had risen less than six feet at Douglas Avenue. This happened again in 1944, when Chatham reported the lowest level in 27 years. Nevertheless some damage took place at Mitchell in that freshet. In 1945, after an unimportant freshet in March, heavy and prolonged rains raised the river to eleven feet above summer flow at London by May 18. This was too low to cause much flooding in the towns, though an aerial photograph of Mitchell shows areas flooded near the dam. It was more than sufficient to

ST. MARYS—*April 7, 1947. Looking North from the C.P.R. tracks at Park Street towards Queen Street.*

ST. MARYS—*July 18, 1950. From the same point.*

overflow flats along the river, damaging crops, marooning cattle and flooding farm buildings. The following year the March flood rose higher, and caused some trouble and inconvenience, but more serious damage was done by the flooding of the low land near the mouth of the river after heavy rains in the first half of June. Farmers in Dover, Raleigh and Tilbury Townships suffered heavy loss of crops between June 17 and June 21, although no notable rise occurred on the upper river.

The April flood of 1947 was considered at the time to equal or surpass that of 1937, However, it was only below London that the water rose to near the same height. The flood may be said to have lasted from March 25 to April 9, at least below Thamesville; for, though there were distinct peaks, there was little relief for the flooded areas. The first rise at London on March 25 caused little flooding, but by the 28th there was high water at Chatham and wide flooding near the mouth of the river. By the 30th 5,000 acres were flooded in Dover Township. The flooded areas were increased by April 5, when there was 12 feet of flood water at Chatham and cellars were flooded. The village of Thamesville was completely flooded and reported twenty feet of water in the river. There had been flooding on both branches at London, at St. Marys and on No. 2 highway near Delaware. The flood had not yet reached its height. Stratford was partly flooded on the 6th and the water at Douglas Avenue in London reached its peak of 20.8 feet above summer flow. West London was temporarily evacuated and the dikes reinforced with sandbags. The flooding here was not serious. It was rather worse in some areas on the South Branch. In all about 150 houses and some factories suffered serious flooding. The private loss did not approach that in 1937. The City spent $11,600 as a direct result of this flood and in the next 9 or 10 months expended $86,069 on improving the dikes and building new ones.

On the rest of the upper watershed the damage to private property was at least as great in 1947 as in 1937. Less public loss was reported, though the items obtained represent only part of the total. From Thamesville down the loss was probably greater in this flood. Some houses near MacGregor Creek in Chatham had four feet of water in their ground floors. The flooded area below Chatham was immense, highways were blocked, farmers were forced to move their families and stock and the spring plantings seriously delayed. Loss of soil by erosion, always serious in the floods of this region, was especially heavy. It seems likely that the total flood cost on the Thames amounted to more than $1,000,000, excluding the cost of the new dikes at London.

The flood of March, 1948, lasted about five days and repeated many of the details of 1947. The height of the rise was nowhere so great as in the previous April and the Thames Watershed suffered less than some other areas in Western Ontario. Nevertheless, the cost of the flood was probably equal to that of 1947. There was flooding at Mitchell, Stratford and St. Marys; at Woodstock, Beachville, Ingersoll and London; and from Thamesville to Chatham. From Chatham down the flood was increased by a heavy rainstorm and by a large ice jam at Prairie Siding. The area flooded was not so great as in 1947 and the flood came at a more seasonable time and did not interfere so much with the planting. There was considerable private loss at Chatham and relatively heavy loss in and around Thamesville. At London the improved dikes kept down the flooding and private loss was light. However, the City spent considerable sums on flood control and river clean-up in 1948.

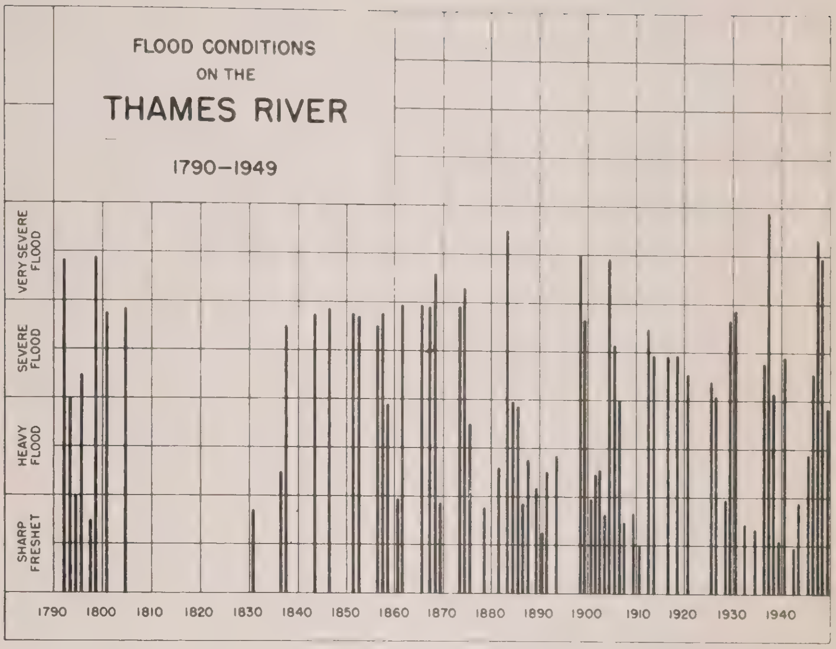
Heavy private loss was again reported from the Beachville area, but the flood appears to have been worse on the North Branch. Mitchell reported $20,000 private loss and the damage to private property at St. Marys was above average. Repair or replacement (in 2 cases) of 78 bridges in Perth County

INGERSOLL—
Strengthening Flood Dykes East of the Town.

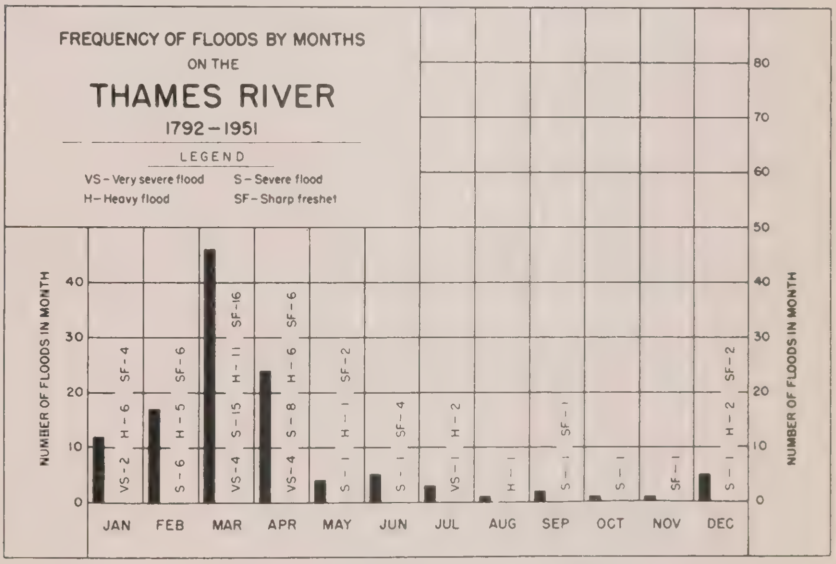
STRATFORD—*Island in Park below Huron Street Bridge disappears under flood.*

cost the municipalities concerned more than $45,000 and about $36,000 of this may certainly be set down as flood cost. There was further damage to municipal property at Mitchell. In the remaining townships and in the other counties damage was equal to or above average for the past twenty-five years. In some cases 1948 is considered to rank with 1937 as the two worst years of flood within that period.

During the past three years several freshets and floods have been reported from the Thames. None of these have been major floods, though the floods of December, 1949, and April, 1950, may be ranked as severe. A number of items of flood cost have been reported from different parts of the watershed, both public and private damage. No one freshet has produced a great amount of damage, but the totals are larger than might be supposed. There is fortunately evidence that the expenditures on protective works and the improvement of bridges etc. are already reducing the amount of flood damage and it is to be hoped that before another major flood occurs on the Thames a large measure of flood control will have been established and that the long story of danger, inconvenience and loss may be brought to an end.



Only the most severe flood in each year appears on the chart. The lines show severity of flooding; not height of rise or volume of run-off.



Floods are shown in the month of their maximum severity. One or two early spring floods are omitted because the month of occurrence is not recorded.

TABLE OF RECORDED FLOODS AND FRESHETS ON THE THAMES

1792 - 1950

1792 - Before April 28. David Zeisberger's Diary for April 28, April 29 and May 1, 1792.
May 17 and June 9. Zeisberger for these dates.
Sharp freshets.

1793 - March 16-19. Zeisberger. Heavy flood.
November 6. Sharp freshet.

1794 - March 11-14. Zeisberger. Sharp freshet.

1795 - March 25. Zeisberger. Sharp freshet.
October 11-18. Zeisberger, October 18. Severe flood.

1797 - March 16-17. Zeisberger. Sharp freshet.

1798 - March 27. Zeisberger. Sharp freshet.
March 30 - April 3. Zeisberger for these dates. Very severe flood.

1800 - April 3-9. Hambly's survey diary, Oxford and Dorchester Townships. Severe.

1804 - September 13-18. Hambly's survey diary, returning from survey of the Sydenham River. Below Chatham. Severe.

1830 - Spring. Sharp freshet or heavy flood.

1836 - April 9. Proudfoot Diaries. Bridge over "Rhodes" mill dam carried away.

1837 - Spring. Manuscript reports of road commissioners. Dam being built at Stratford damaged.

1843 - April 14-16. James Cull's report on bridges, letters in London Herald for April 22. Kilworth and Delaware bridges broken. "Gardiner's Dam in Mosa" broken. Four people drowned.

1846 - March 13 - April 4. Gunn Diaries (copies in Ontario Archives). Severe.

1847 - January 2-12. Gunn Diaries. Heavy flood. April 8-10. Gunn Diaries. Severe.

1851 - February 21-22. Canadian Free Press (London C.W.) for February 21 and 28. Bridges and dams broken.

1852 - March 14. Canadian Free Press (London) for March 18. Bridges and dams broken.

1856 - April 9-11. London Free Press and Daily Western Advertiser for April 10, 14 and 18; Ingersoll Chronicle for April 12. Five thousand dollars damage at Ingersoll, Clark's bridge damaged and Hunt's mill dam destroyed at London.

1857 - February 6 and 7. London Free Press, February 10.
Toronto Globe and Leader, February 11.
St. Marys Weekly Argus, February 12.
Toronto Leader, February 21, quotes Chatham Planet. Severe.

1858 - March 16-17. St. Marys Weekly Argus for March 18. Heavy flood from Mitchell to St. Marys.

1860 - February 24. Toronto Leader for Toronto 25. Sharp freshet. Dam destroyed at London.

1861 - March 1-2. London Free Press for March 4 and 7. Toronto Leader, March 5, 8 and 11. St. Marys Argus, March 7. Sutherland Diaries (Embro), March 1 and 2. Severe.

1865 - March 17-20. London Prototype for March 18. Chatham Planet, March 20. Toronto Leader, March 20, 22 and 25. Sutherland Diaries (Embro), March 20. Severe.

1867 - February 14-17. London Free Press, February 15. Severe.

1868 - March 13-17. Toronto Globe, March 13, 14 and 17. North Middlesex Review, March 20 and 27. Very severe at Chatham.

1869 - March 29. Toronto Globe, March 31. Sharp freshet.
April 18-19. Toronto Globe, April 20. Heavy flood at Stratford.
July 25. Toronto Globe, July 26. Woodstock Times, July 26. Sharp freshet at Stratford and below St. Marys.

1873 - April 7-10. Toronto Globe, April 9, 10, 11 and 19. St. Marys Argus, April 24. Sutherland Diaries (Embro), April 7. Severe.
December 4. Toronto Globe for December 6 and 11. Severe.

1874 - January 22-23. Sutherland Diaries (Embro), January 22. Toronto Globe, January 26 and 28. Very severe.

1875 - March 31 - April 2. Toronto Globe, April 1, 2 and 3. Sutherland Diaries (Embro), April 1. St. Marys Argus, April 8. Heavy flood.

1878 - <u>February 22</u>. Toronto papers for February 23. Sutherland Diaries (Embro), February 23. Sharp freshet at London. <u>March 18</u>. St. Marys Argus for March 21. Sharp freshet on North Branch and Trout Creek. <u>September 13</u>. Toronto Globe, September 14. Sharp freshet at London.

1881 - <u>February 12</u>. Toronto papers for February 14. Sharp freshet with ice jams. <u>March 17-21</u>. St. Marys Argus for March 17; Toronto Globe for March 22. Heavy flood at St. Marys and at Chatham. <u>April 8-12</u>. St. Marys Argus for April 14. Sharp freshet on North Branch and Trout Creek.

1883 - <u>April 10-13</u>. Toronto Daily Mail for April 7, 11 and 14. Severe flood. <u>July 10-11</u>. Toronto Globe for July 12 and 16; Toronto Daily Mail for July 6, 12 and 17, and August 1; London papers for July 11 et seq. Sutherland Diaries (Embro), July 7. Very severe flood in London district.

1884 - <u>February 21 - March 21</u>. Toronto Daily Mail for February 21, 23, March 12, 14, 20 and 22. St. Marys Argus, March 27. Heavy flood on February 21. Ice jam on North Branch and below Forks till March 21.

1885 - <u>April 7, 8</u>. Toronto Daily Mail for April 9. Heavy flood.

1886 - <u>January 4-5</u>. Toronto Daily Mail for January 6. Heavy flood. <u>March 20</u>. St. Marys Argus, March 25. Sharp freshet.

1887 - <u>January 20-26</u>. St. Marys Argus, January 27. Heavy flood on the North Branch. <u>April 3</u>. Toronto Globe for April 5. Sharp freshet at Ingersoll (four people drowned).

1889 - <u>May 31</u>. Toronto Globe for June 1. Heavy flood at London. (Same date as "Johnstown Flood".)

1890 - <u>June 5 and 6</u>. Toronto Mail for June 6 and 7. Sharp freshet.

1891 - <u>February 18-20</u>. London Free Press for February 18 and 23. Toronto Mail, February 26. Heavy floods.

1893 - <u>December 26</u>. Toronto Globe for December 27. Heavy flood.

1898 - <u>March 15-16</u>. London Free Press for March 14 et seq. Toronto Globe for March 14, 15, 16 and 17. St. Marys Argus for March 17 and 24. Very severe flood (especially at Chatham and below).

1899 - February 26-27. London Free Press for February 27. Severe flood. March 12, Toronto Globe for March 13 and 14. Heavy flood. April 14. Toronto Globe for April 15. Sharp freshet at Chatham.

1900 - February 8 and 9. Toronto Globe and Mail for February 10.

February 11-14. Toronto Globe and Mail for February 13 and 15. Heavy flood at Chatham. Sharp freshet at London. April 9. Toronto Globe and Mail for April 10. Sharp freshet at Chatham.

1901 - March 25-30. Toronto Globe and Mail for March 26, 27, 28 and April 1. Heavy flood at London and at Ingersoll. December 14. Toronto Globe and Mail for December 16. Sharp freshet at London.

1902 - March 1. Toronto Globe for March 3. Heavy flood.

1903 - March 8-11. Toronto Globe for March 11 and 12. Sharp freshet.

1904 - February 6-7. Toronto Globe for February 8. Heavy flood. March 24-29. London papers. Toronto Globe, March 25, 26 and 28. Very severe flood. March 31 - April 3. Ibid., April 1-3. Severe flood.

1905 - March 24-27. Toronto Globe for March 25, 27 and 28. Severe flood.

1906 - January 21-23. Toronto Globe for January 22, 23, 24 and 25. Heavy flood. February 28. Toronto Globe, March 1 and 2. Sharp freshet (two men drowned). March 27-28. Toronto Globe for March 28, 29 and April 2. Heavy flood.

1907 - March 14. Toronto Globe for March 15. Sharp freshet.

1909 - February 23-24. Toronto Globe for February 25; Toronto Mail and Empire for February 26. Sharp freshet.

1910 - March 2-10. Toronto Globe for March 3, 8, 9, 10 and 11. Severe flood below Chatham. March 21. Toronto Globe for March 22. Sharp freshet.

1912 - April 1-9. Toronto Globe for April 2-10. Severe floods below Louisville, and in Perth County.

1913 - January 16 - 19. London Free Press for January 18. Toronto Globe for January 20. Heavy flood. March 13. Toronto Globe for March 14 and 15. Heavy flood. March 25 - 26. Toronto Globe for March 26 and 27. Severe flood. April 23. Toronto Globe for April 24. Heavy flood near Woodstock.

1916 - March 28 - 30. Toronto Mail and Empire for March 30 and 31. Severe flood below Chatham (caused by an ice jam).

1918 - February 15 - 20. London Free Press for February 15, 16, and 20. Toronto Mail and Empire, February 15, 16, and 21. Severe flood.
March 29. Toronto Mail and Empire, March 30. Heavy flood.

1920 - March 12 - 21. Toronto Globe for March 13 - 22. Severe flood below Chatham.

1925 - March 18 - 19. Toronto Globe for March 20. Severe flood at Woodstock.

1926 - March 22 - 23. Toronto Mail and Empire for March 24. Severe flood at Woodstock.

1928 - March 25. Toronto Mail and Empire for March 26. Sharp freshet.

1929 - January 18 - 19. -Toronto Globe for January 21. Sharp freshet.
March 13 - 18. London Free Press for March 14, 15, and 18. Toronto Globe, March 15, 18, and 19. Severe flood on North Branch.
April 7. Toronto Mail and Empire for April 6 and 8. Sharp freshet.

1930 - January 7 - 8. Toronto Globe for January 9. Heavy flood.
February 23. Toronto Globe for February 24 - 25. Heavy flood.
February 25 - 26. Ibid., for February 27. Severe flood (especially at Thamesville and below).

1932 - January 6. Toronto Globe for January 7. Sharp freshet.
December 27. Toronto Globe for December 28. Sharp freshet.

1934 - March 2 - 5. Toronto Globe for March 3, 5, 6, and 7. Sharp freshet.

1936 - March 13 - 15. Toronto Mail and Empire for March 14, 16, and 17. Severe flood.

1937 - January 14. Toronto Globe and Mail for January 15. Sharp freshet.

January 25. Toronto Globe and Mail for January 26. Sharp freshet.
April 26-30. Toronto Globe and Mail for April 27, 28, 29, 30. London and Chatham papers. Very severe flood.

1938 - February 6-7. Toronto Globe and Mail for February 7 and 8. Severe flood.

1939 - April 18. Toronto Globe and Mail for April 19. Sharp freshet.

1940 - April 8. Toronto Globe and Mail for April 9. C.N.R. damage report. Severe flood.

1942 - March 18. Toronto Star for March 18. Sharp freshet.

1943 - March 16. Toronto Globe and Mail for March 17. Sharp freshet at London.
May 12. Toronto Globe and Mail for May 13. Sharp freshet at London.
June 28. C.N.R. damage report. Sharp freshet west of London.

1945 - May 18. Toronto Globe and Mail for May 19. C.N.R. damage report. Heavy flood.

1946 - March 7. Toronto Globe and Mail for March 8. Severe flood.
June 18 and 19. Toronto Globe and Mail for June 20. Severe flood.

1947 - March 25-30. Toronto Globe and Mail for March 26, 28, 29 and 31. Severe flood, especially below Chatham.
April 5-10. Toronto Globe and Mail for April 7 and 8. Toronto Telegram for April 5. Toronto Star for April 5, 7, 8, 9 and 10. Chatham Daily News for April 7. C.N.R. damage report. Very severe flood.
June 2. Toronto Globe and Mail for June 3. Toronto Star for June 3. Sharp freshet.

1948 - March 16-21. Toronto Globe and Mail for March 17, 20, 22 and 24. Very severe.

1949 - March 14-16, heavy flood.
December 22 and 23. Toronto Globe and Mail for December 23. Toronto Telegram for December 22 and 23. Heavy flood at St. Marys and London.

1950 - March 28. Toronto Globe and Mail for March 29. Sharp freshet at London.
April 4 and 5. Toronto Globe and Mail for April 5 and 6. Heavy flood.

1951 - January 8-10. Toronto Globe and Mail for January 8. Chatham Daily News for January 8, 9 and 10. Very severe flood below Chatham.

CHAPTER 3

POLLUTION

The Thames River system drains large areas of agricultural land and passes through many urban centres. It has therefore a wide variety of uses, all of which should be taken into account in any study of its sanitary aspects. The watercourses not only function as drainage channels for agricultural land, but also supply water for stock and in a few places for irrigation. The river may also be required to supply drinking water for municipal use and coolant and processing water for industry. It is expected to provide recreation facilities such as swimming and boating, and to supply a sustained annual yield of fish, and cover and food for wildfowl. Its valley should provide attractive scenery for parks and playgrounds. At the present time the river also has to dilute and remove large amounts of industrial wastes, milk wastes and both treated and untreated domestic and municipal sewage. The control of all these uses is therefore a very complex problem.

Polluted water may be classified according to the source of the pollutant and the severity of its effects. The chief sources of pollution are milk wastes (from creameries and cheese factories), cattle droppings, sewage (both raw and treated[1]) and various industrial wastes. There is also a group of substances such as fibre, sawdust and silt which are not normally considered as pollutants, but which may render the river bottom unsuitable for fish or unproductive of bottom fauna.

Pollution effects are of two kinds: those affecting public health and those which are not a hazard to human health but which are offensive to people or harmful to fish and other aquatic organisms. The first type can usually be measured by the concentration of an indicator organism (the bacillus *E. coli*). The second type is measured in terms

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1. Sewage effluents may be bacterially inoffensive but harmful because of a too high chlorine content.

of poisonous compounds which may be introduced into the river and in terms of oxygen depletion and the oxygen demand[1].

The commonest type of pollution is that caused by the discharge of wastes containing dissolved or suspended organic compounds. Domestic sewage and most industrial wastes are predominantly of this type. Certain bacteria and other organisms cause the decomposition of these organic compounds by consuming the organic solids and combining them with oxygen. The resulting shortage of oxygen in the water is one of the chief symptons of a polluted stream.

Biological decomposition of organic compounds in the presence of dissolved oxygen in water is called aerobic decomposition[2]. It finally results in the formation of compounds such as carbon dioxide, water, nitrates and sulphates. Being comparatively stable, they exert no further demand for oxygen, produce no foul odours, and do not cause septic conditions in the water. They do however fertilize the water and stimulate the growth of plant and animal life in the stream. Dense growths of green algae are normally a sign that the stream is recovering from organic pollution.

In the absence of dissolved oxygen in the water "anaerobic decomposition" of organic wastes takes place. Oxygen is then consumed from the organic materials and compounds remain such as methane gas, hydrogen sulphide gas, ammonia and others having little or no oxygen. Many of these products have highly disagreeable odours typical of polluted waters. Sometimes the decomposition products are lethal to fish and other aquatic organisms, but more often these die from lack of oxygen.

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1. The B.O.D., or Biochemical Oxygen Demand, is a measure of the oxygen that will be demanded by the material in the course of its complete oxidation biochemically. It is determined wholly by the availability of the material as a bacterial food and by the amount of oxygen utilized by the bacteria during its oxidation.

2. Proper treatment of sewage wastes should include two phases, primary treatment (mechanical removal of most solids) and secondary treatment (digestion of the remainder by aerobic decomposition, as here described.)

Since the amount of oxygen water can dissolve is so small[1], sewage treatment facilities should be designed to turn out an effluent that is already decomposed biologically so that the stream's oxygen reserves will not be called upon to an appreciable degree for this purpose.

The types and abundance of both plant and animal species in a stream provide an excellent measure of the condition of the water. At the one extreme severely polluted waters may contain extensive growths of gray-brown fungi, vast numbers of scavenger types of bottom-feeding organisms, a great bacterial population and little or no dissolved oxygen. At the other end of the scale clean waters will support green algae, insect larvae, snails, clams, game fish and other organisms requiring abundant oxygen.

The time and distance required for recovery of a polluted stream depend on many factors, such as the temperature and volume of flow of the water, the type of pollutant and its dilution, the amount of dissolved oxygen in the stream at the polluting effluent, the type of stream bed and the types of obstructions such as dams.

A full report on pollution on the Thames would require that the following work be carried out:

(a) Bacterial plate counts at all points suspected of bacterial pollution, and at regular space intervals in the river's course elsewhere.

(b) Measurement of the oxygen content in bacterially polluted sections and where industrial wastes enter the river, with additional measurements of the Biochemical Oxygen Demand below sources of industrial and bacterial pollution in order to estimate the rate of recovery of the river.

(c) Assessment of pollution sources.

Time was not available during the 1950 conservation survey to collect samples for plate counts or to carry

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1. Less than 20 parts of oxygen per million parts of water by weight.

out extensive B.O.D. measurements. Plate counts and measurements of dissolved oxygen have in fact already been made both by the Provincial Department of Health and under the auspices of several cities and towns on the river. In 1948 an extensive bacterial survey was made of conditions in and near the city of London, sponsored by the city's Medical Officer of Health and the University of Western Ontario. A survey of the chief pollution sources outside the city of London was therefore considered to be the most useful contribution which could be made in 1950.

1. Agricultural Pollution

The chief sources of agricultural pollution are the drainage from barnyards which are close to streams, and direct pollution from cattle which are allowed access to the river. The effects of these in the Thames are not severe, although pollution from cattle was noted at 92 of 240 stations on the river and its tributaries examined during the stream survey described in the Wildlife section of this report. Severe pollution by cattle is found only in the smaller tributaries. This condition was found at 16 of 240 stations visited. If there is permanent flow the tributary frequently recovers to a fair quality a short distance down stream from gross agricultural pollution, and the bacterial pollution in such streams has no harmful effect unless the stream is to be used for drinking or swimming. Elimination of agricultural pollution from the streams of Southern Ontario does not appear to be possible at the present time.

2. Urban Pollution

Urban pollution includes the domestic sewage of all the large municipalities on the Upper Thames, including London, Woodstock, Ingersoll, Stratford, St. Marys, Mitchell, and from smaller centres such as Thorndale and Embro, together

POLLUTION

—LEGEND—

CREAMERIES AND CHEESE FACTORIES

1 WITH EFFICIENT MILK WASTE TREATMENT

2 LACKING EFFICIENT MILK WASTE TREATMENT

HEAVY URBAN POLLUTION (CHIEFLY FROM SEWAGE)

SCALE 0 1 2 3 4 5 MILES

with wastes from commercial and industrial institutions in the urban areas, whether or not they are tied into any existing sewage facilities.

At the time of the survey (summer 1950) no municipality on the Upper Thames Watershed possessed adequate sewage disposal facilities. The cities of London, Woodstock, Stratford and Ingersoll all operate disposal plants, but in every case the facilities were overloaded, in need of repair or by-passed in some degree. None of the smaller towns or villages (Mitchell, St. Marys, Embro, Beachville, Dorchester, Tavistock) possessed sewage disposal facilities.

The stream most seriously polluted by municipalities along its course is the South Branch of the Thames, which has often been described as an open sewer. The sewage plants at Woodstock turn out an effluent that is little altered from raw sewage with most of the solids removed.

The river has scarcely begun to recover from the serious effects of this pollution before it receives a further load from a large creamery at Beachville. By the time the stream enters the city of Ingersoll it is again showing signs of recovery, but here it receives a further setback. It is very regrettable that the Ingersoll sewage plant, which is now one of the most modern and efficient disposal plants in Canada, was not designed to take the wastes from the creameries, cheese factories and other industrial plants in the town which still seriously pollute the river. There are also still effluents reaching the river directly from the residences and septic tanks not yet connected to the municipal system.

On the North Branch and its tributaries, industrial and sewage wastes reach the river at Stratford, St. Marys and Mitchell. The City of Stratford operates a disposal plant with activated sludge treatment. The plant, when not loaded beyond its capacity, is capable of turning out a very clear effluent with a low oxygen demand, but the system is

frequently overloaded. The Avon River flow is very low in summer. Industrial pollutants are also reported to be reaching the river from various storm drains. These combined factors have created septic conditions in the stream and this has interfered with the use of the water for agricultural purposes. The Engineering Department of the City of Stratford has shown considerable initiative in its attempts to locate all possible sources of pollution. Possible sources reported in the Engineer's Report for the year 1949 were considered to be:

(a) Effluent from sludge storage
(b) Effluent from the treatment plant
(c) Storm overflows from both storm sewers and sanitary sewers

The fact that there are many effluents into two covered creeks complicates the problem. It is suggested that the Provincial Department of Health might provide technical help and equipment for making B.O.D. tests on the river and creeks at Stratford. The report stated that "This assistance could not be obtained in 1949". Milk wastes increase the pollution lower down the Avon, but a heavy growth of green algae indicates a "recovery zone" reaching down to the confluence of the Avon and the Thames. Mitchell and St. Marys possess no sewage disposal facilities so that effluents from industries (chiefly creameries) enter the streams directly. It appeared that at least a few domestic outlets have been connected into the towns' storm sewers.

Because of its size, the city of London is potentially the most serious source of pollution on the watershed. Large-scale disposal facilities have been in operation for many years but these are now overloaded. In addition, a number of suburban establishments were not connected with existing disposal facilities at the time of the survey.

If present plans are carried through to completion London should cease to be a serious polluter of the Thames. Specifications for enlarging and improving the

present system have been drawn up; a good deal of this work is now under way or has been completed since the survey was made. The University of Western Ontario, formerly one of the chief suburban offenders, is now connected into the city's sewerage system. Once London has cleaned up its own pollution problems it will be in a better tactical position from which to encourage other municipalities on the Thames River to follow its example.

3. Suburban Industrial Pollution

The most important stream polluters in the suburban areas of the watershed are milk-products factories. In a few cases (Mitchell, St. Marys, Thorndale and other communities of similar size) factories of this type also contribute to the municipal sewage load entering the streams, but there are also twenty-four milk products factories scattered through the agricultural lands of the watershed. Analysis of the facilities for disposal of wash water and whey showed the following result:

(a) Factories equipped with septic tanks (some of these tanks were not in usable condition)	14
(b) Factories equipped with settling bed only (most of the beds were overloaded)	5
(c) Factories with no settling bed (effluent passing directly to stream or drain)	5

Of the 24 factories, 14 lacked adequate facilities for dealing with fluid wastes. These 14, which are sources of pollution, are plotted on the map "Biological Conditions of Streams" in the Wildlife section of this report.

Milk-products wastes are of two types: (1) washings from milk cans and processing machinery, and (2) waste products of the factory, such as whey and buttermilk.

Creameries are concerned with butter manufacture. The most important creamery wastes are can and tank washings, drainage and washings from pipe lines, separators, churns,

storage tanks and other equipment, skim milk and buttermilk. These frequently are allowed to enter streams and are a most objectionable source of pollution.

In cheese factories the effluent varies according to the variety of cheese produced. In general, rennet, acid or some other souring agents are added to the milk in the cheese vats and a separation of the casein in the form of a curd results. When the whey has been processed and drawn the cheese is washed several times with running water. The chief wastes from these processes are the usual can and equipment washings, liquids from the several cheese washings and the whey.

In former times many cheese factories required the farmers who brought milk in for processing to take cans of the whey away with them for use as fertilizer or food for farm stock. Nowadays few processing plants require this of their suppliers and much whey flows off with the washing waters. Even without this additional load cheese washings contain about 20 per cent of the whey because it cannot be completely drawn from the cheese in processing.

An efficient septic tank provides an adequate primary treatment for milk waste. But it must be of proper capacity. Where the dilution factor in the stream is large secondary treatment may not be necessary. In other situations an efficient secondary treatment device such as a sand filter or a field-tile bed should be installed to treat the effluent from the septic tank.

4. Recapitulation

While the Thames and tributaries are bacterially polluted at every large population centre which they encounter, the oxygen balance in the water is normally only locally upset. The South Branch is much more seriously affected than the North Branch, since it receives heavy loads of industrial wastes as well as both treated and untreated sewage. Both branches are

heavily polluted at London, and the river below London is also foul. The occasional presence of decomposing algae in the North Branch between London and St. Marys does not indicate the presence of much untreated sewage, since the effluent from treated sewage also promotes the growth of algae.

From the point of view of municipal water supplies there is at present no problem on the Upper Thames, since no water is at present taken from the river for drinking or culinary purposes. If water is taken from the proposed lake at Fanshawe for municipal supplies it will of course be physically and chemically treated.

The crux of the problem on the Thames is the question of other uses of water, particularly its use for watering stock and its use for recreation, including swimming and for production of fish. The requirements for purification of public swimming pools are strictly enforced in city swimming pools in the Province, but these are not commonly enforced in the rivers of Ontario, although many rivers are intensively used on holidays by large numbers of people. It appears that some extension of the present system of controls would be an advantage.

So long as some municipalities and other public bodies ignore the Provincial legislation against stream pollution, no one can expect industrial companies to improve their conditions. The present legislation concerning pollution is both so general and so severe that in many cases it cannot be enforced without disrupting the economic life of the Province. Since the provisions are difficult to enforce, abuses are now common. Any changes in the present legislation must obviously be made in such a way that no company is made to feel that it is handicapping itself (compared with others) in taking the lead in pollution abatement.

The solution appears to lie in defining more exactly the requirements of water purity, not only for public health but also for industrial uses and for the propagation

and protection of fish and wildlife. The States of New York and California provide examples of how this can be done. Their water problems are at least as complex as those of the Province of Ontario, but each has already:

(a) set up a Water Pollution Control Board.

(b) adopted a classification of waters for particular uses and a set of standards of quality and purity which are to be applied to them.

(c) set up a permit system for control of all new outlets including those for industrial wastes.

The present classification in New York State includes seven classes of fresh water based on its destined use, such as drinking, culinary processes, agricultural uses, bathing, fishing and industrial uses.

Control of new outlets is extremely important. Article 6 of the Public Health Act, State of New York, reads in part:

> "After the effective date of this article, any person desiring to make...any new outlet for the discharge of sewage, industrial waste or other wastes...into the waters of this state, shall first make application to the board for a permit to construct and use such outlet. If, after hearing, the board finds that the discharges from such proposed outlet will not be in contravention of the standards adopted by the board, such permit shall be issued to such applicant, so conditioned as the board may direct."

A similar control of all new outlets in Ontario appears to be the logical first step. When and if it is completed, the second step of controlling the present outlets will have a greater chance of success, particularly if a set of water standards is established, based on the intended use.

The dams recommended for construction on the Thames would noticeably increase the summer flow of the river. They would help to reduce the effects of the present pollution and to improve conditions for fish, but the need for rigid control of existing and new industrial and domestic pollution outlets will remain.

CHAPTER 4

UNDERGROUND WATER

1. General*

No consideration of river valley development, or of conservation, or of re-development of agricultural areas, could be adequate or in any way complete without some mention of that water which occurs beneath the surface of the earth, and particularly of that part of the subsurface water that is within the zone of saturation, the ground water. For it is this water that is primarily responsible for the continued flow of surface streams and that supplies, to a very great extent, our domestic and industrial needs.

The water of the earth may be divided into three:

(a) Water in the atmosphere
(b) Water on the surface of the earth
(c) Water below the surface of the earth

The water below the surface may in turn be divided into three:

(1) That above the zone of saturation
(2) That in the zone of saturation
(3) That in the interior of the earth

The water in the atmosphere is perhaps primarily the concern of the meteorologist; that on the surface, of the hydraulic engineer; but that below the surface is directly the concern of the geologist, the agriculturalist, and the engineer.

There is, in general, an upper limit within the earth's crust below which the permeable rocks are saturated; this upper limit is called the water table and it forms the surface of the zone of saturation. The water within this zone is the ground water.

Practically all the water recovered from the zone of saturation, that is, ground water, is derived from the

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* Caley, J. F. Underground Water Supplies. Department of Planning and Development Report, 1945.

atmosphere. Most of it reaches the earth in the form of precipitation, either as rain or snow. Of the precipitation falling on the ground, part is immediately carried away by streams as surface run-off, part evaporates, either directly from the surface and from the upper mantle of soil, or by transpiration of plants, and the remainder sinks into the ground ultimately to be added to the ground-water supplies.

The proportion of the total precipitation that sinks into the ground will depend largely upon the type of soil or surface rock and the topography of the area upon which the moisture falls; if the surface deposits are of sand or gravel more water will sink in than if those deposits were of clay; if the region is hilly and dissected by numerous valleys more water will immediately drain away than if the surface is fairly flat and but little dissected. Steady precipitation over considerable periods will furnish more water to the ground-water supply than will torrential rains; in this case the run-off may be nearly equal to the total precipitation. Moisture falling after the ground surface is frozen will not usually find its way below the surface and therefore will not materially replenish the ground-water supply. Light rains falling during the growing season may be wholly absorbed by plants. The quantity of moisture lost by direct evaporation depends largely upon temperature, wind and humidity.

It is evident, then, that the percentage of the total precipitation disposed of by run-off, evaporation, or percolation below the surface is difficult to determine and depends to some extent upon local factors.

That part of the precipitation that sinks into the ground finds its way downward until it reaches the ground-water level or until it comes into contact with a layer of rock which is impervious to its passage; such a layer may hold water some distance above the general ground-water level. This

is known as perched water. If the ground-water level is at or near the surface there will be a lake or swamp; if it is cut by a valley, there will be a stream.

The conditions under which ground water occurs and the factors determining its quantity, quality, and possible recovery are many. This water is directly associated with the rock into which it percolates and as this rock may (and in south-western Ontario does) vary in its physical properties from place to place, so will the conditions affecting the ground water change.

Because of the large quantities of water that are daily consumed from underground sources, it may be thought that precipitation cannot furnish the entire supply. However, when it is remembered that a layer of water one inch deep over an area of one square mile amounts to about 14,520,000 imperial gallons and that in south-western Ontario the annual precipitation is perhaps in the order of 30 inches, it will be seen that over 420,000,000 gallons fall on each square mile each year. If we estimate that only 10 to 20 per cent (surely a conservative estimate) of the annual precipitation reaches the zone of saturation, there is still an appreciable quantity of water available to recharge the ground-water supplies.

It is not implied that the ground-water supplies are inexhaustible. So long as the annual recharge, that is the quantity of water reaching the zone of saturation, is equal to or greater than the quantity withdrawn, the ground-water supplies will not materially decline. Unfortunately, however, there are parts of south-western Ontario where this condition does not prevail. It is common knowledge that once permanent streams are now dry, that many springs have disappeared and many wells have failed. Such a condition is in large measure the result of cutting down of forest trees, draining of swamps, and bringing into cultivation areas that

perhaps should have been left as woodlots. In general, the same quantity of moisture is falling now as before the streams ceased flowing, but so far as ground water is concerned one of the most important results of the aforementioned conditions is the great increase in surface run-off, culminating all too often in disastrous floods and reducing greatly the quantity of water that formerly went to recharge the subsurface supplies. Couple with this the increase in population with its ever increasing demand upon ground water for both domestic and industrial needs, and it is not difficult to see that the ground-water resources will still further decline unless some remedial measures are taken.

Getting back to the geology of ground water; all sedimentary rocks are to some degree porous, that is, they possess pores between the individual grains of which they are composed. Water stored within the rocks mainly occurs as filling these spaces. A very fine-grained rock containing water may have such small pores that the attraction between the rock and water is great enough to hold the water in the rock; such a rock will not yield its water to wells. Those rocks that yield their water readily are called aquifers; those that do not are impervious beds.

For the present purpose the geology of south-western Ontario may be divided into two parts; the bedrock and the overlying unconsolidated glacial deposits.

The bedrock consists of layers of limestone, shale and sandstone that, when viewed at an isolated outcrop, generally appear to be flat-lying, but that regionally are known to dip from 10 to perhaps 40 or 50 feet a mile in a general south-westerly direction. These rocks are sedimentary in origin, having been formed from sediments deposited in bodies of sea water later to be consolidated into hard rock.

The water-bearing properties of the various types of rock constituting this sedimentary succession vary greatly.

In general, the shales, being fine-grained, are the poorest aquifers, while the sandstones and limestones are considerably better.

No special study of the water in these rocks has been made, but they have been mapped over much of south-western Ontario so that the distribution, thickness, and general physical characters of the several formations are fairly well known. In the area bordering Lake Erie, the bedrock has been penetrated to various depths by wells drilled for oil and gas, and a study of these drilling records has yielded some general data regarding water. Thus it is that we know of occurrences of fresh water generally in the upper part of the bedrock; of sulphur water somewhat lower; and of salt water at still lower depths.

Overlying the bedrock is the glacial drift. During the final stages of geological history great accumulations of ice formed at several centres in Northern Canada. Due to the pressure exerted by the immense thickness of ice, the ice moved out in all directions from these centres, covering large areas with a continental ice sheet. As the ice advanced it picked up great quantities of loose rock which it carried along and which was deposited when the ice finally retreated by melting. This material is unconsolidated and called glacial drift. Several advances and retreats of the ice sheet took place and each retreat left its accumulation of drift on the surface over which it passed.

Thus, over most of south-western Ontario the bedrock is covered with drift ranging in thickness from zero in parts of the Bruce Peninsula to over 600 feet in the region north of Toronto.

Generally, the drift consists of boulders and pebbles of various composition and size embedded in a matrix of clay to form a more or less impervious mass called boulder clay. Intermingled with this, and commonly in a most complex

manner, and also lying above, below, and between successive tillsheets are beds, lenses and pockets of waterlaid sand and gravel which form the chief water-bearing members of the drift.

Throughout the greater part of south-western Ontario most of the ground-water supplies are directly associated with the glacial drift.

2. Oxford, Middlesex and Perth Counties *

(a) Oxford County

This county, lying as it does, according to Chapman and Putnam, in the Central Plain between the two ends of the Horseshoe Moraine, is favoured with relatively thick drift. Presumably, supplies from the drift sufficient for the needs of rural areas are available almost everywhere in the county. In addition, there are valley trains composed of sand and gravel which should serve as particularly good sources of ground water. Also, surface sands and gravels over a considerable area adjacent to Norfolk County, brought about by deposition from ice-front streams pouring south-west into Lake Whittlesey south-west of Brantford, serve as good storage media.

A survey made by the Agricultural Representative at the time of the 1944-45 drought led to the conclusion that certain areas of the county were rather badly off as regards ground-water resources. These included areas around Brooksdale in West Zorra Township, the southern part of East Zorra, the part of Blandford lying between Bright, Innerkip, Gobles and Drumbo, and an area near Richwood. It is believed that most of the difficulty was with shallow wells and that it was relieved when the wells were drilled deeper. About 100 wells (2 per cent of those reported upon) experienced a water shortage in this drought. Over half of the wells were stated to be drilled wells, some as deep as 240 feet and in rock or

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* Gwynne, C. S. A Preliminary Ground Water Survey of Southern Ontario. Department of Planning and Development Report, 1946, unpublished.

close to it.

Woodstock, Ingersoll, Tillsonburg, Norwich, Thamesford, Tavistock and Otterville all obtain their water from either springs or wells. Woodstock is stated to have developed a spring outside of the town and also has a well or wells approximately 160 feet deep in the city park, which draw from limestone of the Norfolk formation. The well is reported to be 397 feet deep, and presumably is a considerable distance into bedrock. The bedrock of the area thus appears to serve as a reliable source of ground water. Securing the best available information on the water supplies of these two communities and of any other wells which draw from the bedrock would seem highly advisable.

The Norfolk formation, comprised essentially of limestone, directly underlies the mantle of the western part of the county, approximately 70 per cent of its area. This is flanked on the east by belts of the Bertie-Akron and Salina. Ordinarily, wells drilled beyond the upper part of these formations might be expected to furnish only salt or sulphurous water but, as pointed out above in connection with the discussion of the supplies of Woodstock and Ingersoll, the possibilities should be more definitely determined, particularly with regard to the limestone beds of the Norfolk.

The water supplies of Tavistock, from wells 25 feet deep, and from Norwich, from wells 138 feet deep, are obtained from sand and gravel probably of valley-train origin. The supplies of both Tillsonburg and Otterville were reported to be from flowing wells and to be of poor quality. The Tillsonburg wells are west of the city and about 100 feet deep. The water is believed to come from the drift.

In summary, the impression has been gained that there is no shortage of ground-water supplies in rural areas in this county. Shortage which has been experienced came from the use of shallow wells, and the deepening of such wells

usually improved the situation. Many deeper wells, however, were also stated to have been affected by the drought, and many attempts to find water at the base of the drift or in the upper part of the bedrock were unsuccessful. It is believed that as far as this county is concerned, emphasis at present should be placed upon acquiring more information regarding the ground-water geology in the vicinity of Woodstock and Ingersoll.

(b) Middlesex County

The mantle of this county is prevailingly thick, generally, so that in rural areas satisfactory water supplies may be secured from within or at the base of the drift. Most of the county is ground moraine, but there are several clay moraines of the Horseshoe Moraine, and there are valley trains between and at the ends of these moraines. The deposits of sand and gravel on the surface, formed by glacial waters along spillways and outlets, are favourable for ground-water accumulation. No water-supply problems in rural areas during recent periods of drought, except possibly in the vicinity of Melborne, are reported. Here, as elsewhere, shallow wells, particularly in till, have failed in time of drought. No difficulty in securing water in drilled wells is reported, although wells drilled into bedrock are always confronted with the possibility of striking salty water.

Several communities in this county depend upon subsurface supplies. These include London, Strathroy, Glencoe, Lambeth and Parkhill, and the water in each case is believed to come from sands and gravels in the drift. The wells at Strathroy are only 30 feet deep and those at Glencoe have a maximum depth of 147 feet. The smaller wells at Strathroy are thought to be located in a valley-train deposit. Strathroy was not visited, but according to report there is no difficulty in the bringing in of new wells through the use of sand-points. So far as known, all of these supplies are reasonably potable, except the one at Parkhill, which is reported to be sulphurous in character.

The surface bedrock of most of the county is the Hamilton formation (mostly shale and a smaller amount of limestone) in the western part, and the Norfolk formation composed of magnesium and calcarious limestones in the eastern part. Presumably, as elsewhere, fresh-water supplies from the fissures near the top of these formations may with luck produce potable water. Non-potable water is a greater possibility, particularly if the wells go to any depth in the bedrock. One flowing well at the west end of the Springbank Park, believed to have been drilled into the bedrock, produces a highly sulphurous water.

For the time being there seems to be little need of detailed study of the ground-water geology in rural areas or in any of the towns of this county using well or spring water except London. With its present population of 94,000 and further growth in prospect, it would seem logical that as complete knowledge as possible with regard to the ground-water resources of the vicinity be developed. A thorough and detailed study of the Pleistocene in this vicinity is first in order so that the extent and relations of all water-bearing sand and gravel deposits may be learned. Inspection of the well records of the International Water Supply Company and the Public Utilities Commission of London should contribute to this study.

(c) Perth County

In spite of the fact that Perth is covered with a variety of glacial deposits, wells drilled to or into the bedrock are reported to be widespread and numerous. This suggests either that the drift is thin at least in some places, or that it is poor in available ground water, or that supplies from the bedrock are better. The glacial deposits include clay moraines, which are part of the Horseshoe Moraine, and sand moraines, also ground moraine and valley trains. The valley trains are, of course, along the principal natural

drainage lines and in some cases connecting them. Eskers are a prominent feature in Elma Township. A drumlin area extends north from Listowel.

No difficulty appears to have been experienced as regards subsurface supplies in the rural areas, although as stated it is notable that wells are drilled in bedrock, many of them as much as 180 or 200 feet in depth. In the vicinity of Mitchell the rural wells are reported to go to the bedrock, at an approximate depth of 75 feet, where they strike good water. The practice is to case off sand and gravel acquifers in the mantle because water from these sources is likely to contain troublesome silt or fine sand. The mantle is reported to be approximately 75 feet thick at Listowel, where a plentiful amount of water under pressure is found at the top of the bedrock. Wells in the vicinity of Stratford are also reported to secure their water from bedrock.

Stratford, St. Marys, Listowel, Mitchell, and Milverton have supplies from springs or wells. That for the first two of these apparently comes from limestone (Onondaga) of the Norfolk formation. The artesian well at St. Marys has a depth of 150 feet and Stratford has six wells ranging in depth between 550 and 650 feet; these wells penetrate 100 to 125 feet of mantle.

Listowel has three wells, ranging in depth from 240 to 338 feet; the water is probably from the Akron-Bertie. The Milverton supply comes from the bedrock, either the Akron-Bertie or the Salina, and that of Mitchell from an acquifer in the drift.

There are believed to be no immediate ground-water problems in this county . The matter thought to be most in need of study when the time becomes available is that of the ground-water resources of the bedrock. It would seem from the available evidence that the limestone of the Norfolk (and most of it is limestone of one sort or another) contains

considerable fresh water, much of it obtained from wells within the formation. Its quality should be confirmed and the extent of the area from which suitable supplies might be drawn determined.

3. Farm Water Supply

A survey of farm water supply on the watershed of Trout Creek and a portion of the watershed of the Middle Branch of the Thames was begun in the middle of October 1945. Two hundred and eighty-seven reports were obtained from farmers in the Trout Creek area -- about 95 per cent of the occupied farms. A number of other farms were visited where reliable information could not be obtained owing to the absence of the owners. Whenever possible in these cases information was obtained from neighbours, but this could not always be done. Heavy snowstorms in December interfered with the work by closing some of the side roads with drifts. It was not possible to complete the survey of the Middle Branch above Embro, as was intended. Over one hundred reports were collected from this area, however, and it was covered sufficiently to indicate that conditions here are very similar to those in Trout Creek. The area on the Middle Branch affected by the lowering of the underground water supply which appears to have taken place in the last 50 or 60 years is perhaps slightly greater in proportion than that on Trout Creek. The farms reporting shortage of water lay mostly along the divide between the watersheds.

The Trout Creek Watershed is, on the whole, well watered. There are a number of strong springs on the sides of the valleys and the creeks fed by these intersect most of the area. In some places, however, fairly wide stretches of the original high tableland remain uncut by valleys, and these areas are dependent on underground sources of water. These include some of the best farmland in the district.

It had been reported that farmers in some parts of the watershed had been suffering from shortage in recent

years. This proved to be the case in several areas along the divides between the different creeks. A shortage of water had been very widely felt during the winter of 1944-5. Many farmers reported that they had had to haul water for their stock during that winter for the first time. Others had hauled water from time to time for some years past.

A number of reports of unsatisfactory wells were given in the area south-west of Stratford, in the fourth, fifth, sixth and seventh concessions of South Easthope Township. The land here is high, flat, not too well drained and rather bare of trees. A group of farms on the highland between Trout Creek and the Middle Branch, north-west of Maplewood in Zorra West Township, reported scarcity in recent years. In some cases wells were being drilled at the time of the survey. Part of this group was within the watershed of the Middle Branch.

In the neighbourhood of Harrington a number of farms in the first, second, third, fourth and fifth concessions of Zorra West reported shortage in dry seasons. South and west of Harrington there is a large group of wells which were drilled 30 or 40 years ago. Many of the owners of these wells gave failure of the old wells as the reason for drilling. These various groups of wells, with others on the boundary between Perth and Oxford Counties, form a rough circle around the valley in which the village of Harrington lies, near the junction of two main branches of Trout Creek. It is fairly evident that since the turn of the century there has been a change in the level of the ground water along these heights.

Very few reports of poor supply were given in the small portions of Blanshard and Nissouri East Townships which lie in the Trout Creek Watershed. In these two sections there is a very large proportion of drilled wells, many of long standing. Most of this area consists of the high table-land and in the valleys the limestone is very close to the

surface. Some wells in the thirteenth and fourteenth concessions of Downie Township form part of this group.

In the "Gore of Downie", which lies almost entirely within the Trout Creek Watershed, there were a great many reports of scarcity in recent years. In the eastern section these chiefly referred to the exceptional winter of 1944-5. In the south-west angle of the "Gore", several of a group of wells from 20 feet to 25 feet in depth were reported as giving trouble of late years. Two of the owners of these wells were inclined to attribute this to the increase of under-drainage. In one of these cases a stretch of woodland had recently been cleared and drained.

Of the 357 wells on which reports were obtained, 266 were dug wells. These wells vary greatly in depth, the average for the watershed being 22 feet. They can be divided into two general classes - the ordinary dug wells, usually more than 20 feet deep, in which the depth of water varies with the amount of precipitation, and the shallower wells, called by their owners "spring wells", in which there is a fairly constant level of water at from 2 to 4 feet. Very few shallow wells wholly dependent on surface seepage were reported on the watershed.

The first of these types of dug well was, in former times, the most usual source of water supply in the area. Many of these wells have been replaced by drilled wells of some form, and others, all over the watershed, were reported as going dry periodically. Some of these have been giving so much trouble that the owners were drilling new wells when visited or intended to do so as soon as possible. Speaking generally, it may be said that wells of this type, less than 30 feet in depth, are no longer satisfactory for watering stock or as the only supply. Very frequently a well about 20 feet in depth and curbed with stone was still in use for domestic supply; while the well used for the stock was from 10 to 20 feet deeper and curbed with brick, indicating that it

had been constructed at a later date than that at the house. When some kind of mechanical pumping system has been installed on the deeper well, the house well has often gone out of use altogether. These disused wells are not included in the table at the end of this chapter.

In many places it has been found necessary to dig to a greater depth to obtain a satisfactory supply. Wells of from 40 to 60 feet are not uncommon, and even greater depths are found occasionally. Two wells 90 feet deep were reported. One of these was an exceptional case, the well having been dug deeper, after water had been found, to avoid quicksand. The other 90-foot well formed part of a group of deep wells in Lots 33-35, Concession VII-VIII in Zorra West. This group of four wells included one of 47 feet, one of 50 feet and one of 87 feet, besides the 90-foot well already mentioned. As a rule, all the deeper wells were giving a good supply of water.

The wells reported as "spring wells" were usually giving a satisfactory supply. They were often found in the neighbourhood of flowing springs and in many cases such a spring was used as a supplementary supply. They were usually said to have a constant depth of a few feet of water and when it was reported that they could be pumped dry it was almost invariably added that they filled up again in a few hours. A few of these wells were reported as overflowing.

A number of farms on the watershed depend on springs for their whole water supply and others use the springs to a greater extent than their wells. There are groups of strong springs used for this purpose along the valley of Trout Creek from Harrington to St. Marys, and others are found in the Gore of Downie, near Harmony, on the Stratford-Embro road, and in the neighbourhood of Fairview. In a few cases there were reports that the springs were giving less water of late years or even going dry. These were always springs that were being used in addition to wells. In one of these cases it was

believed that planting had materially improved the flow.

A few small ponds were being used for stock. As these were, in every case, fed by springs and of small area, they are included with the springs in the table of Farm Water Supply. One or two farmers reported that their cattle used kettle ponds to drink from in pasture.

The impressions received from this survey are that the Trout Creek Watershed as a whole is well supplied with water under present conditions; that there was a marked tendency to shortage in many parts of the watershed about forty years ago, which led to extensive deepening of wells and drilling for water; and that shortage of water is felt at the present time in scattered localities, particularly in winter.

There seems to be good reason to connect this lowering of the ground water after 1900 with the cutting of many of the woodlots which had survived until about that time. The effect of under-drainage on the water supply is less certain, but the belief is widely held that this has a great deal to do with the failure of some of the wells. The present shortage is attributed in part to more stock being kept. Modern practices also involve a larger consumption of water per head of stock than was the case in the past. When "spring wells" are used, on the other hand, it has often been found that modern water systems which draw evenly on the water supply are more satisfactory than the old method of pumping up large quantities two or three times a day.

Conservation measures in general would certainly have a beneficial effect on the farm water supply of the area. But, as the shortage is more acute on the higher ground, the restoration of woodlots and the protection of kettle areas, whether ponds or swamps, would seem to be more important in this respect than other measures which are concerned rather with the valleys than with the tableland itself.

FARM WATER SUPPLY

ON THE

TROUT CREEK WATERSHED

Townships	Creeks*	Springs	Dug Wells	Drilled Wells	Wells Sometimes Dry	Wells Giving Good Supply
Easthope S.	9	4	83	10	33	60
Downie	27	22	80	21	22	79
Blanshard	6	4	12	14	2	24
Nissouri E.	13	10	26	22	6	42
Zorra W.	29	36	65	24	23	66
Totals	84	76	266	91	86	271

*Used for watering stock

CHAPTER 5

HYDRAULICS

1. General Hydraulic Problems

Hydraulics as applied to conservation deals with the measurement and control of run-off from river drainage basins. Measurement has to do with such factors as precipitation - both rain and snow - the topography and vegetative covering of the area and the daily gauging of the flow of the river at selected points. Control deals with the prevention of floods by the use of reservoirs and other structures, and the increase of summer flow.

Floods which are caused by the natural run-off from river basins have occurred from time to time in Southern Ontario ever since records were first kept. Evidence of these can be found in diaries going back well over 150 years and from newspaper records for at least 100 years. Most of this run-off occurs in the spring, with the result that there is too much water in our rivers at the time of the year when it is needed least and very little, if any, during midsummer when it is required most. In addition to the flooding which is caused by spring run-off, occasional floods also occur during the summer on watersheds which have little natural protection. These summer floods do serious damage to crops. Such floods are not confined to a few of our largest rivers, but records show that all rivers of any consequence have from time to time caused serious damage in this way.

When Ontario was mostly covered with forest and the natural reservoirs, such as large swamps, had not been interfered with, severe flooding probably was not as frequent as it is today because these two factors had an ameliorating effect on the flow of water. Land clearing and drainage were necessary to open up the country for agriculture, but in some respects these were carried beyond the point of necessity, thereby aggravating the flood situation. In order now to regain

a more or less stable condition of the rivers and streams, certain conservation measures must be carried out, such as the reclaiming of large swamps and water storage areas, the reforestation of marginal and submarginal land, and also by a program of proper land use as indicated by farm planning, whereby run-off from gently sloping land can be controlled by such methods as contour cultivation and grass land where such is indicated. Such methods aim to control water where it falls on the land. If this could always be done it would be the ideal solution of the flood problem. But to minimize the required flood storage in a large watershed, a program of improved land use would need the co-operation of a great many individual farmers. This would take many years to accomplish. More immediate measures are therefore also necessary, especially where urban centres are frequently flooded.

One of the first problems facing the hydraulic engineer is to estimate or measure the run-off from a drainage basin which causes flooding farther down the valley. This includes a careful examination of rainfall over the years at different times of the year, which in turn presupposes that weather stations have been established in the area. Topography, types of soil, the amount of vegetative covering, particularly tree growth, on the area, and the gradient of the river, which has a bearing on the rapidity with which the water travels to the river's mouth, must all be carefully studied. If no gauging stations have been established then the run-off must be computed by taking the above factors into consideration and an approximate figure of flow is then determined by comparison with a neighbouring drainage basin which has gauge records in order to decide how much protection by the use of reservoirs is required. If, on the other hand, gauges have been established, by which a daily record is kept of the amount of water going down the channel at certain points, then a more accurate determination can be made of how much protection is needed. Fortunately,

at London on the North and South Branches of the Thames there are hydrometric records dating from 1915, and at other stations on the watershed for shorter periods, and although the years of records for the latter are short they may be correlated with the long-term records and usually dependable run-off ratios established.

After the amount of run-off has been measured by whichever means are available to the engineer, it will give him a figure of flow which will indicate how much of this water will have to be held back by different methods in order to give the necessary protection where flooding is taking place. This means that a reconnaissance survey of the whole watershed must be made in order that suitable valleys be selected where dams can be built for the storing of the required amount of water. When more than a sufficient number of such reservoir sites have been selected, each must be measured as to its capacity, and the required number chosen to hold back sufficient water to solve the flood problem. In addition, wherever a dam is to be built, some subsurface exploratory work must be done at the site to make certain that the dam will have a proper foundation. Only after this preliminary work has been carried out can the reservoirs be finally chosen, the actual designing of the dam structures undertaken and the work carried through to completion.

While conservation reservoirs are usually built for the purpose of preventing floods, they are needed just as much in Southern Ontario for increasing summer flow. This has become increasingly important in recent years because rivers with extreme low flow and those which dry up entirely are a health menace to the communities through which they pass. Summer flow is necessary for flushing out the channel; to furnish water for industrial plants; for the practice of good agriculture; and is absolutely necessary for dilution where urban municipalities empty the effluent of their sewage disposal plants or raw sewage into the river.

The building of dams for the prevention of flooding and the increasing of summer flow is a comparatively new concept in engineering. It is only since the turn of the century that structures cf this kind have been used for this purpose.in North America. The older methods included such projects as straightening and widening the river, narrow bridges and other man-made works which might obstruct the flow or cause ice jams. Also, occasionally, for such work a river was diverted into another watershed, or dikes were built to hold it within its banks. Such practices are aimed at one thing only, namely to get rid of water as quickly as possible. They do not take into consideration the necessity of holding water at the head-waters for deep infiltration or retaining it for summer flow throughout the year. On some rivers in Ontario channel improvements, diversions and even dikes must be carried out and built, especially where dams and reservoirs are not economical and summer flow is not a major problem.

2. The Upper Thames Watershed

(a) General Description

The Upper Thames Watershed comprises the drainage area of the Thames above the confluence of Dingman Creek with the main river ten miles south-west of the city of London. It measures 51 miles in length (north and south), has a maximum width of 37 miles, an average width of 26 miles and an area of 1324.9 sq. miles. The watershed is drained by two main branches and their tributaries, known as the North Branch and the South Branch, their confluence or "the Forks" being near the south-westerly limits of London. The Middle Branch is a major tributary of the South Branch, its confluence being approximately 16 miles above the Forks at London. Major tributaries of the North Branch are the Medway River which joins the North Branch about three miles above the Forks, Trout Creek which joins the North Branch at the town of St. Marys and the Avon River which joins the North Branch about four miles above St. Marys.

The rate of run-off[1] into these rivers and their tributaries is very high; so much so that the banks in places are unable to contain the flood waters and the low areas are flooded. Floods may occur at any time of the year but it is the floods which occur during the spring break-up that are frequent and most severe, and it is these floods which are the concern of this report.

(b) Cause of Floods

The topography, soils and other natural features of the watershed contribute in a great measure to flooding. The impervious clay soils, the high gradient of the river bed, and the steep lateral slopes of the tributaries increase the rate of run-off (Fig. H-1). There are no lakes or swamps which have been left untouched to serve as natural reservoirs; also, a high percentage of the forest has been removed. In addition

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1. Run-off is the amount of water that the drainage area supplies to the open streams and is the excess of precipitation over evaporation, transpiration and deep seepage.

there is a network of municipal drains above London which includes the straightening and widening of smaller creeks. These works undoubtedly increase the rate of run-off and aggravate floods.

The above adverse physical conditions are constant, but the magnitude of spring floods depends largely upon precipitation and temperature and the condition of the ground, that is, whether it is saturated or frozen. The depth and weight of the snow pack and the direction and the velocity of wind are also important factors. The most adverse combinations of factors, however, for a spring flood are frozen or saturated soil covered with a heavy snow blanket, accompanied by heavy rain and unseasonable prolonged high temperatures. Such floods may be further aggravated by ice jams impounding large volumes of water which, when the jams break, surge down and boost the flood peak.

The towns and cities subject to serious floods are London, St. Marys, Mitchell, Woodstock and formerly Ingersoll, now relieved by channel improvement. (Figs H-2, H-3 and H-4 show the flooded area for each of the above places.)

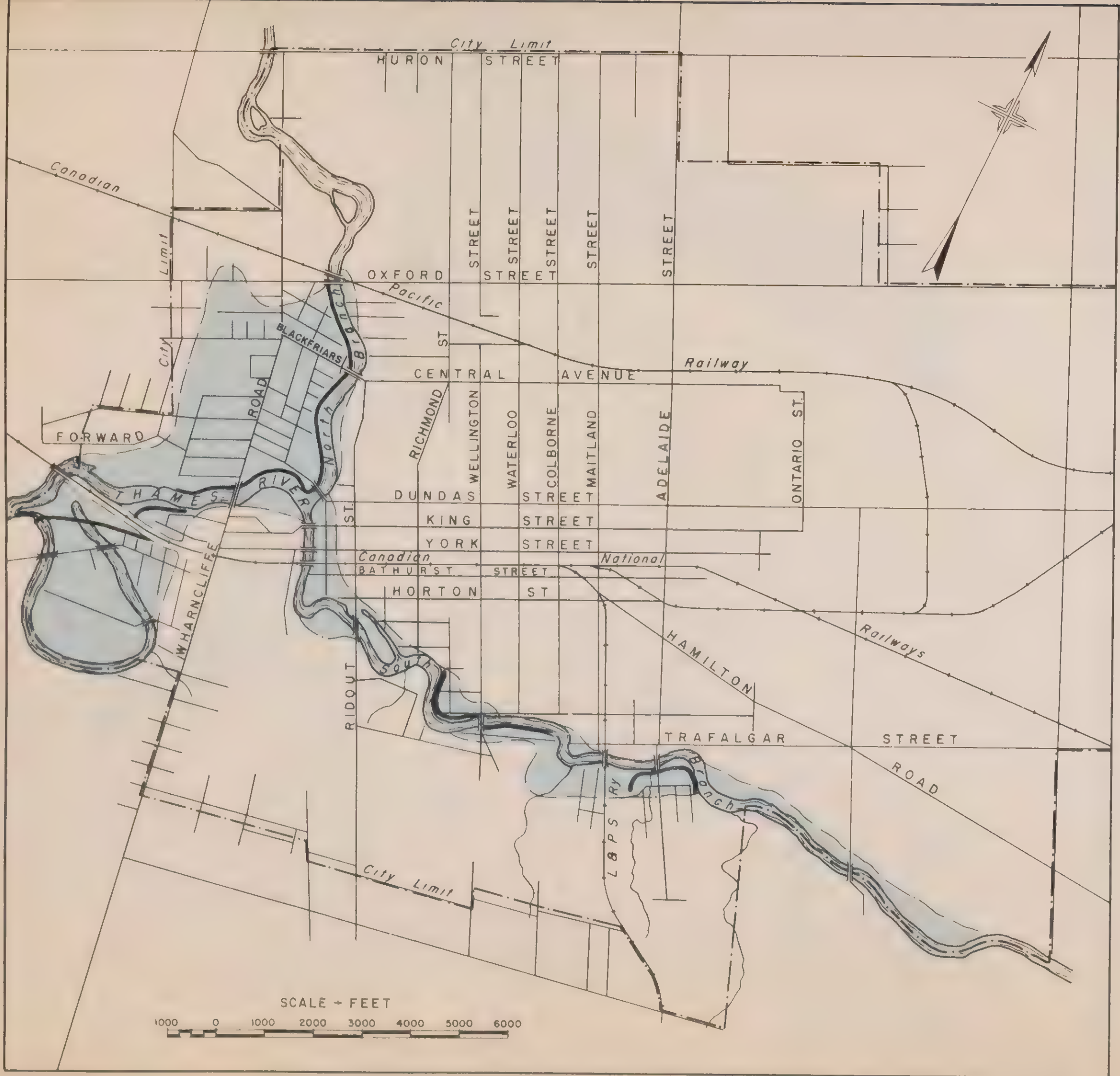
(c) Remedial Measures for Flood Control and Low Summer Flows

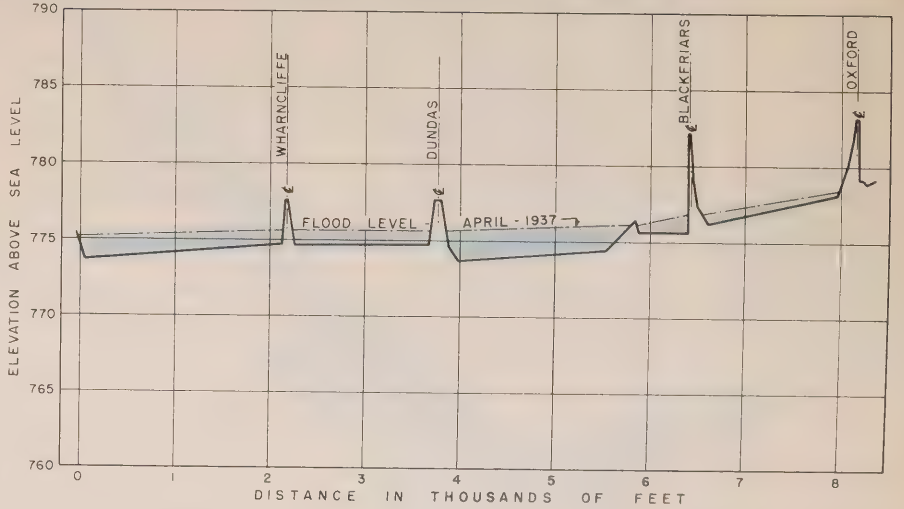
Of the above places subject to floods, London has sustained the greatest damage. Owing to its location at the Forks, it is in the most vulnerable position on the river, consequently in planning the location of required storage this fact has been kept in mind; but at the same time requirements for the safety of smaller municipalities up stream have not been overlooked. Low summer flows in both branches of the Thames are also a major problem and measures for both problems are complementary.

The land use and reforestation conservation measures recommended in this report are an essential part in any plan for flood relief and increasing low summer flows, but of themselves, even though immediately implemented, would not be sufficient to solve either problem and must be supple-

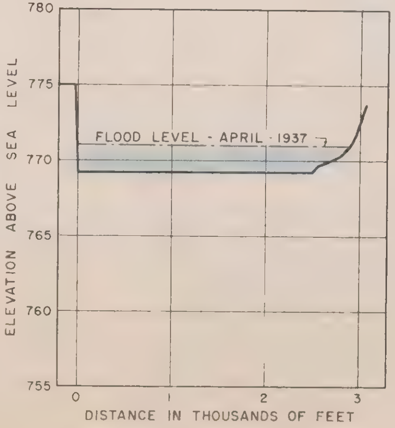
mented by storage of water in conservation reservoirs up stream which will reduce the flood crests to a safe stage, and later during dry periods may be released to increase the low flows.

Dikes and channels are aids only to a flood problem and should be considered as expedients. The benefit is local and they do not conserve water but have the reverse effect of speeding flood waters past the trouble area and often aggravate flooding down stream. Some diking and channel work, however, is sometimes necessary in conjunction with reservoir control when sufficient storage is not available or is too costly.





PROFILE OF DYKE IN LONDON WEST

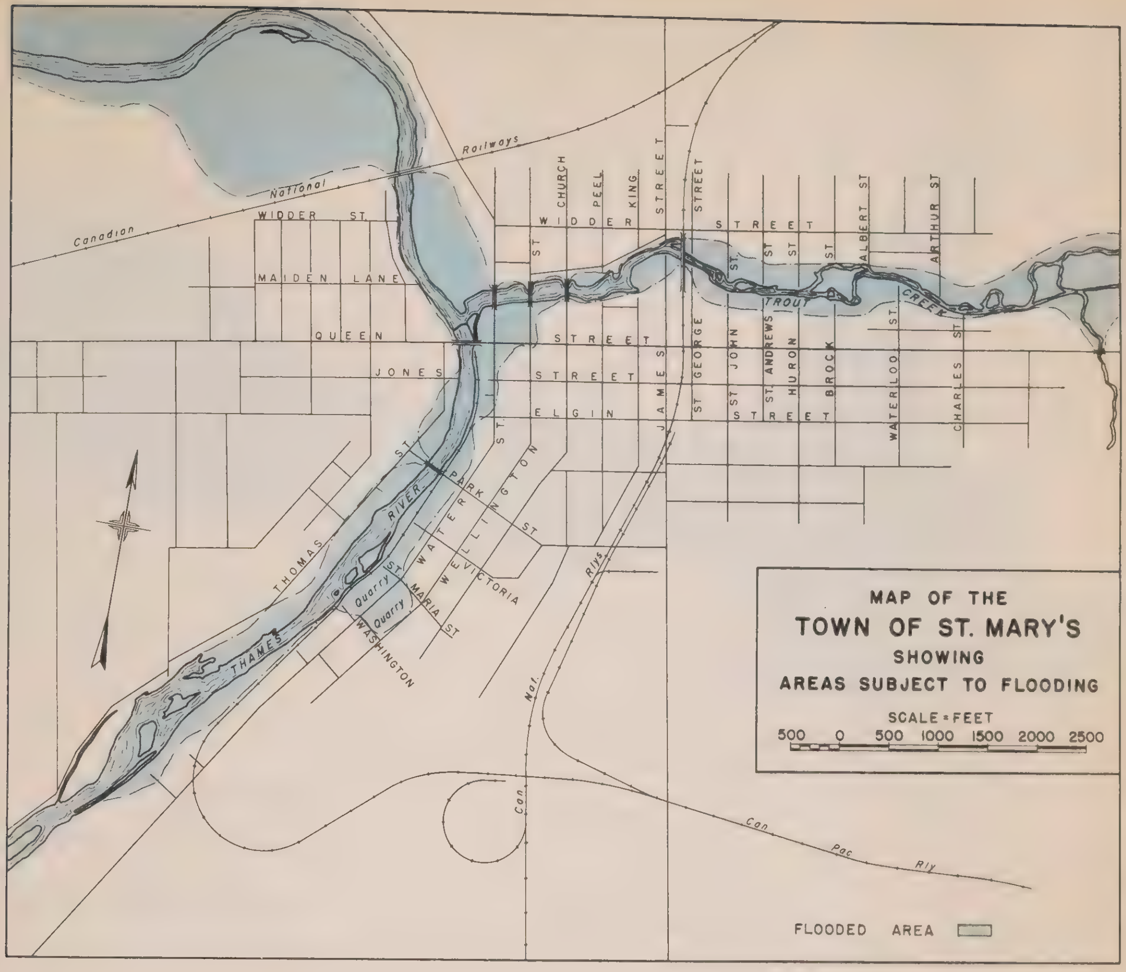


PROFILE OF COVE DYKE

MAP OF THE
CITY OF LONDON
SHOWING
AREAS SUBJECT TO FLOODING
AND EXISTING DYKES

FLOODED AREAS
EXISTING DYKES

FIG. H-2


MAP OF THE
TOWN OF ST. MARY'S
SHOWING
AREAS SUBJECT TO FLOODING
SCALE = FEET
500 0 500 1000 1500 2000 2500
FLOODED AREA
Canadian National Railways
Can. Pac. Rly.
Can. Nat. Rlys.
THAMES RIVER
TROUT CREEK
WIDDER ST.
MAIDEN LANE
QUEEN STREET
JONES STREET
ELGIN STREET
THOMAS ST.
PARK ST.
WATER ST.
WELLINGTON
VICTORIA
WELLINGTON ST.
MARIA ST.
Quarry St.
Quarry
WASHINGTON
CHURCH ST.
PEEL
KING
JAMES STREET
STREET
ST. GEORGE
ST. JOHN
ST. ANDREWS ST.
HURON ST.
BROCK ST.
ALBERT ST.
WATERLOO ST.
ARTHUR ST.
CHARLES ST.

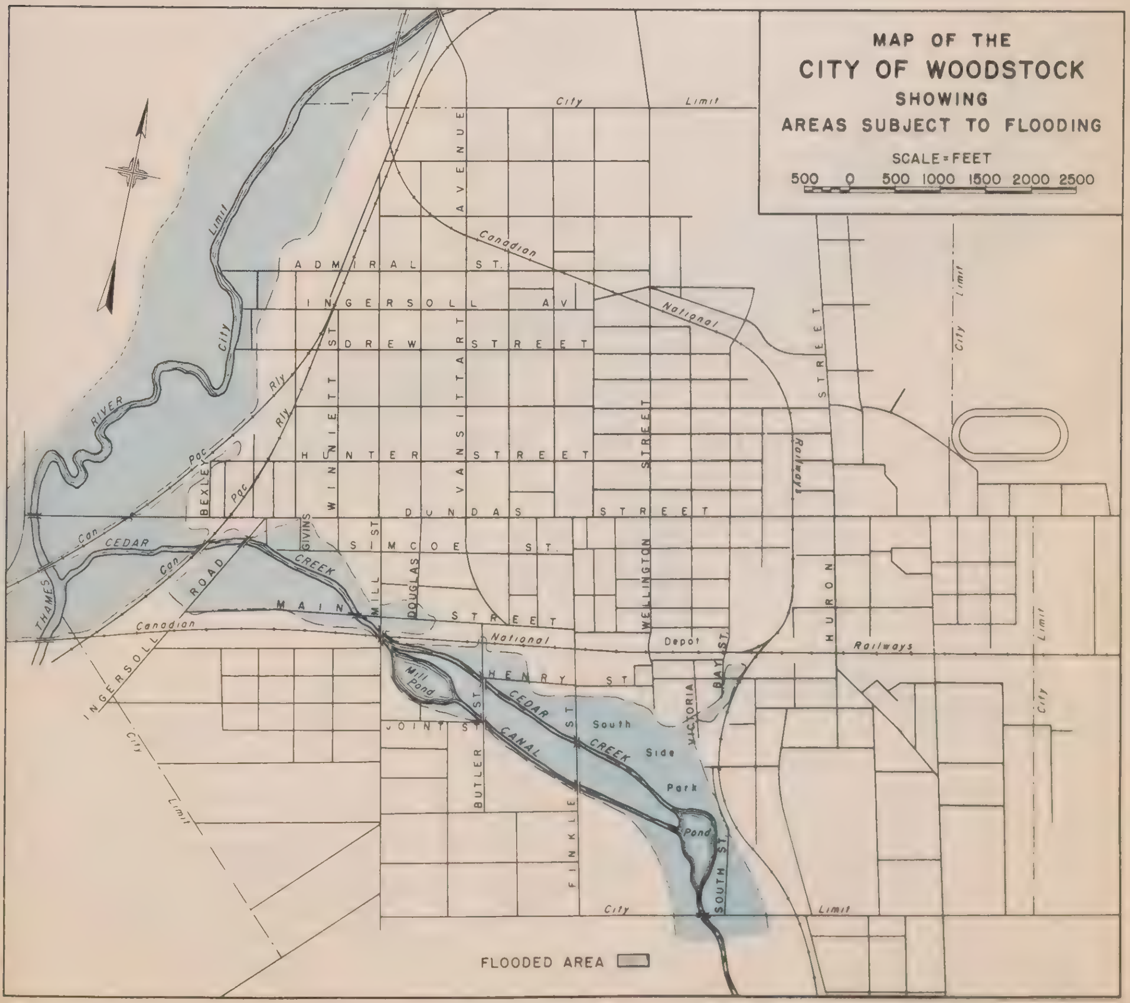
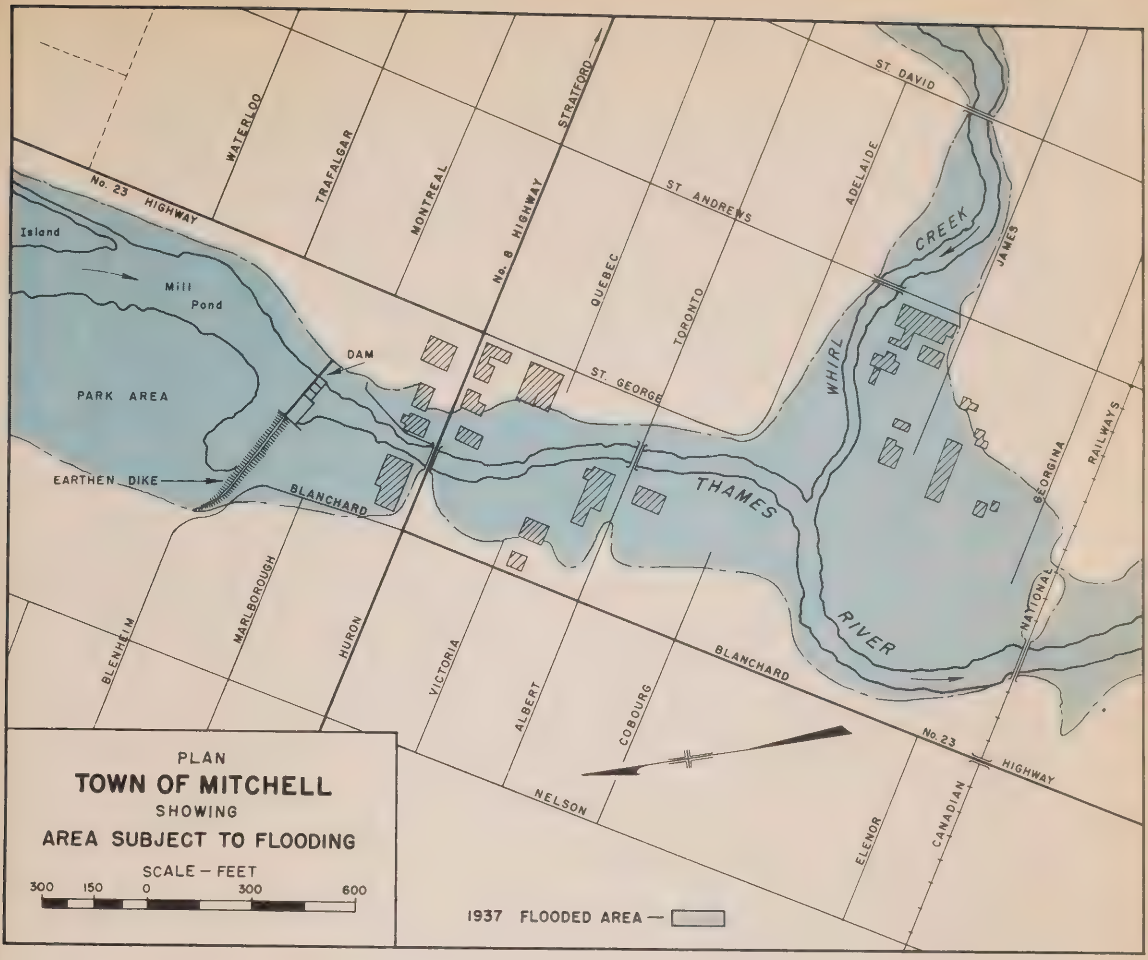
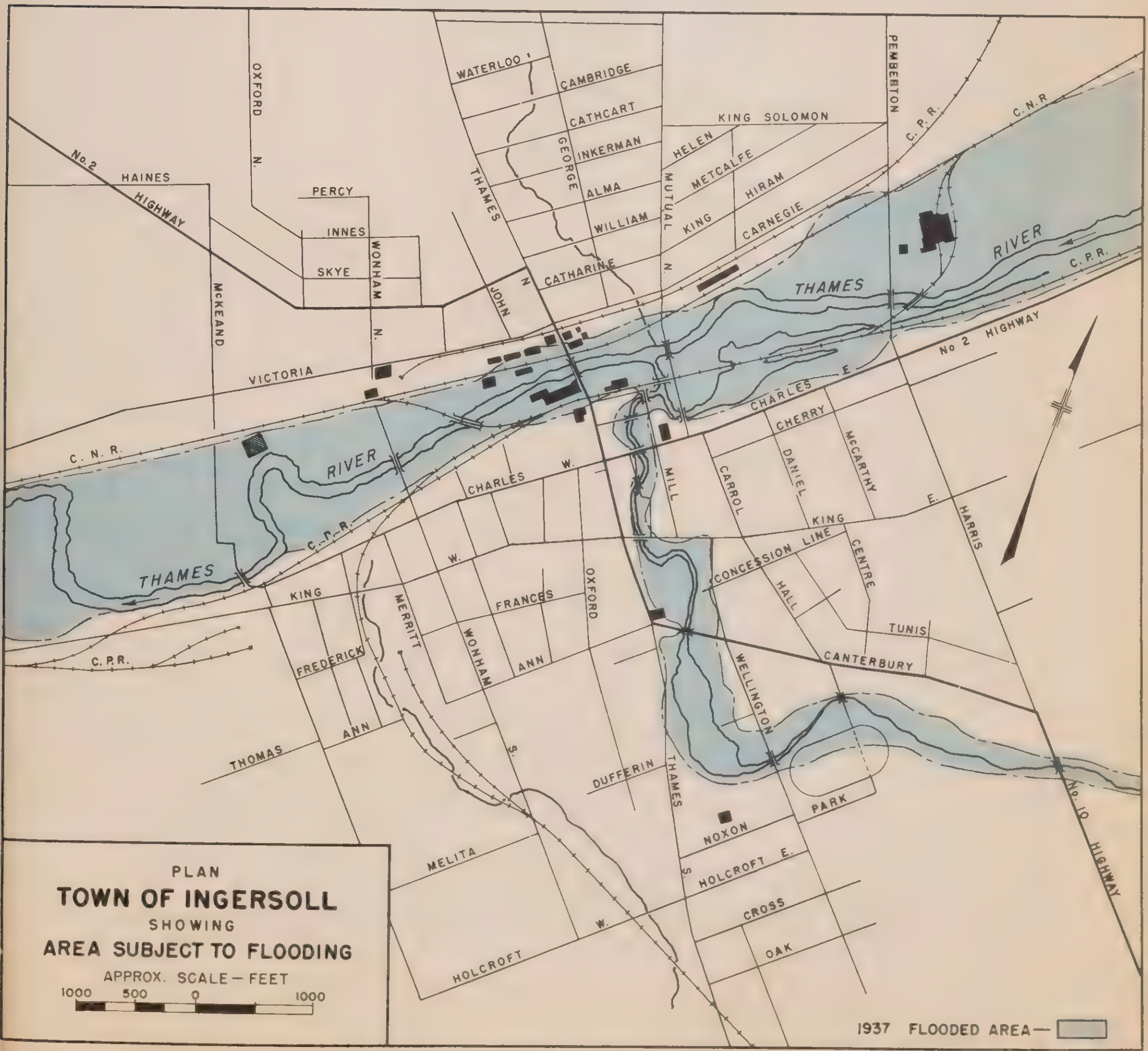

MAP OF THE
CITY OF WOODSTOCK
SHOWING
AREAS SUBJECT TO FLOODING
SCALE = FEET
500 0 500 1000 1500 2000 2500
FLOODED AREA
City Limit
THAMES
RIVER
CEDAR CREEK
CEDAR CREEK
CANAL
Mill Pond
Pond
South Side Park
Canadian National Railways
Can. Pac. Rly.
Depot
ADMIRAL ST.
INGERSOLL AV
DREW STREET
HUNTER STREET
DUNDAS STREET
SIMCOE ST.
MAIN STREET
HENRY ST.
JOINT ST.
INGERSOLL ROAD
BEXLEY
GIVINS
WINNIETT ST.
VANSITTART AVENUE
MILL ST.
DOUGLAS
BUTLER ST.
FINKLE ST.
WELLINGTON STREET
VICTORIA
BAY ST.
SOUTH ST.
HURON STREET

FIG. H-3



PLAN
TOWN OF MITCHELL
SHOWING
AREA SUBJECT TO FLOODING
SCALE – FEET
300 150 0 300 600
1937 FLOODED AREA —
WATERLOO
TRAFALGAR
MONTREAL
STRATFORD
No. 8 HIGHWAY
No. 23 HIGHWAY
Island
Mill
Pond
PARK AREA
DAM
EARTHEN DIKE
ST. DAVID
ST ANDREWS
ADELAIDE
CREEK
WHIRL
JAMES
QUEBEC
TORONTO
ST. GEORGE
THAMES
RIVER
GEORGINA
RAILWAYS
NATIONAL
CANADIAN
BLANCHARD
MARLBOROUGH
BLENHEIM
HURON
VICTORIA
ALBERT
COBOURG
NELSON
ELENOR
No. 23
HIGHWAY



PLAN
TOWN OF INGERSOLL
SHOWING
AREA SUBJECT TO FLOODING
APPROX. SCALE – FEET
1000 500 0 1000
1937 FLOODED AREA —
OXFORD N.
WATERLOO
CAMBRIDGE
CATHCART
INKERMAN
GEORGE
ALMA
WILLIAM
PEMBERTON
KING SOLOMON
HELEN
METCALFE
HIRAM
KING
CARNEGIE
MUTUAL N.
C.P.R.
C.N.R.
No. 2 HAINES HIGHWAY
PERCY
INNES
SKYE
WONHAM N.
THAMES
JOHN N.
CATHARINE
RIVER
THAMES
C.P.R.
No 2 HIGHWAY
McKEANO
VICTORIA
CHARLES E.
CHERRY
DANIEL
McCARTHY
C. N. R.
RIVER
CHARLES W.
MILL
CARROL
E.
HARRIS
KING
C.P.R.
W.
CONCESSION LINE
CENTRE
THAMES
KING
MERRITT
FRANCES
OXFORD
HALL
TUNIS
C.P.R.
FREDERICK
WONHAM
ANN
CANTERBURY
WELLINGTON
ANN
THOMAS
S.
DUFFERIN
THAMES
PARK
No. 10 HIGHWAY
NOXON
S.
HOLCROFT E.
MELITA
CROSS
W.
OAK
HOLCROFT

FIG. H-4

3. The Solution of the Flood Problem

(a) Future Floods

The flood which caused the most damage, at least in recent years, occurred in April 1937. The exceptional flood flows on the South Branch were an all-time high, but on the North Branch the highest flood flows actually occurred in 1947 and would have caused greater damage in London had the South Branch been correspondingly high and had not part of the dike system been raised and extended after the 1937 flood. From these floods it will be seen that, in order to give protection for the future, provision must be made not only for floods of known magnitude but for greater ones which in all likelihood will occur during the years ahead.

It is difficult to state with accuracy what these greater floods might be, but in planning protection for the municipalities of the Upper Thames it has been considered sufficient to provide for protection equal to one-third more than the greatest known flood of the past, namely the flood of the South Branch in 1937 and the flood of the North Branch in 1947 if they should occur together, which they might well do, at some future date. This was the factor of safety provided for by the engineers who prepared the official plan of the Muskingum Conservancy District. Such a probable flood of the future is termed an hypothetical flood and will be referred to as such hereafter in this report.

(b) Storage Required

The flood control storage required for the hypothetical spring flood for the North Branch is 80,734 acre feet[1] and for the South Branch, 30,346 acre feet. The total for the Forks at London is 111,080 acre feet. The plan is designed for such operation that all the reservoirs would be filled to spillway level but not beyond, in the case of a spring run-off

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1. An acre foot is a volume one acre in area by one foot in depth and is equivalent to 43,560 cubic feet.

with a magnitude equal to the hypothetical flood. During such a flood the outflow from the reservoirs, including the run-off from the uncontrolled areas below the reservoirs, would not exceed the safe carrying capacity of the channels below. Should the hypothetical flood be exceeded in magnitude, then the reservoirs would have to discharge the flood waters at a greater rate than planned and there would be some flooding.

(c) <u>Distribution of Storage</u> (Fig. H-5)

The distribution of the 111,080 acre feet of storage should be as near as possible to the ratios of the spring run-off volumes of the tributaries above London. This ratio is 73.77 per cent or 81,944 acre feet for the North Branch and 26.23 per cent or 29,136 acre feet for the South Branch.

The North Branch is well provided with reservoir sites. The chosen sites are well located strategically and their storage capacity is in fair proportion to their respective drainage areas. The South Branch, however, is not so well favoured with reservoir sites. The Thamesford site on the Middle Branch[1] is the only one which has a capacity comparable to those of the North Branch. The other two sites are small and alone are inadequate for the protection of Woodstock. Also over half of the South Branch drainage area is uncontrolled. There is, however, sufficient storage in the South Branch, as the amounts below indicate.

Reservoir storage available in North Branch	80,734	ac. ft.
Reservoir storage available in South Branch	30,346	ac. ft.
Total	111,080	ac. ft.

The uncontrolled area of the North Branch is 97 square miles or 14.76 per cent of the North Branch drainage area. The uncontrolled area of the South Branch is 277.9 square miles or 53.55 per cent of the South Branch drainage area.

Table H-1 shows the storage capacity for each of the reservoirs surveyed and the distribution of the storage relative to London, St. Marys and Woodstock.

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1. A tributary of the South Branch.

UPPER THAMES RIVER WATERSHED

SHOWING

PROPOSED CONSERVATION RESERVOIRS

CHANNEL IMPROVEMENTS

AREAS SUBJECT TO FLOODING

GAUGING STATIONS

AND

DRAINAGE AREAS

FIG. H-5

(d) Low and Increased Sustained Flows

Reservoirs which are used for the storage of water for summer flow, as well as for flood control, may be regulated for the summer months only, which would yield more flow during this shorter period; or, more preferably, extended over the balance of the year in order to dilute the effluent from domestic sewage and industrial waste. May is usually a wet month and the reservoirs would be full on June 1, and about that time storage would be used to increase low flows. June 1 to September 20 - 112 days - constitutes a summer period. June 1 to March 1 - 273 days - covers a yearly period, March 1 being about the time of the break-up, when the reservoirs would shortly be filled again.

From Table H-2 it will be seen that the summer of 1939 and the winter of 1940 was the driest yearly period since 1915. The driest summer period was in 1936, the mean monthly flows at London on the North Branch being only 12 c.f.s. in August and on the South Branch being only 22 c.f.s. in July. The mean daily flows were even lower, being 9 c.f.s. for 9 days of the month on the North Branch and 12 c.f.s. for 4 days of the month on the South Branch. Conservation reservoirs will correct this adverse condition, as may be seen in Table H-A below and in Tables H-3 and H-4, which account for the conservation storage. In examining these tables it should be noted that all reservoirs may be used for summer flow except Fanshawe.

It may be pointed out here that the Thames below London will benefit not only by the increased flow but also from the greatly reduced flood crests as well. The proposed reservoir system will control the run-off from 802 square miles or approximately 36% of the entire Thames Watershed area and would be invaluable at such times when the lower Thames River alone was in flood, as in January, 1951. Under these conditions the flow from above London could be cut off completely and held until the flood danger below has passed.

TABLE H-A

SUSTAINED FLOWS AT LONDON BY THE REGULATION OF CONSERVATION RESERVOIRS - (FANSHAWE EXCEPTED)

Branch	Period of Days	Average Daily Discharge from Reservoirs - Conservation Storage Only		Sustained Flows at London	
		Driest Year on Record c.f.s.	Average Year c.f.s.	Driest Year on Record c.f.s	Average Year c.f.s.
North South	112 112	150.2 87.6	152.4 89.1	201.3 161.5	325.5 277.5
North South	273 273	60.0 33.8	61.3 33.9	128.4 104.2	455.6 263.4

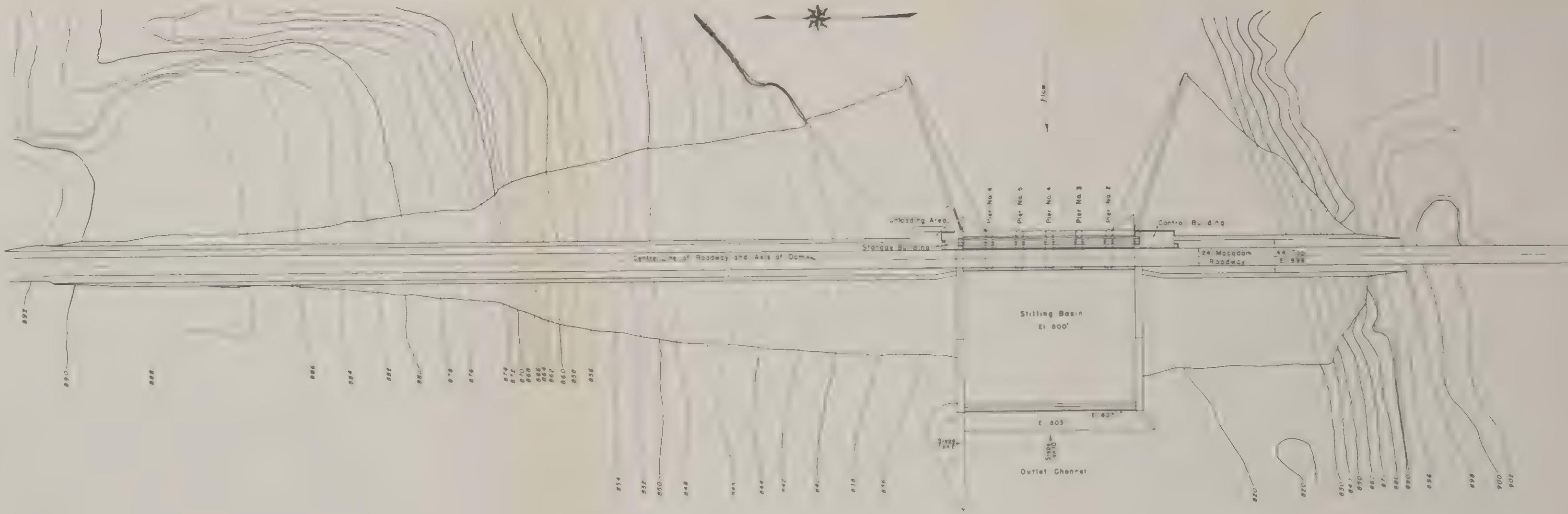
(e) Proposed Dams and Reservoirs

(1) Fanshawe Dam and Reservoir (Fig. H-6)

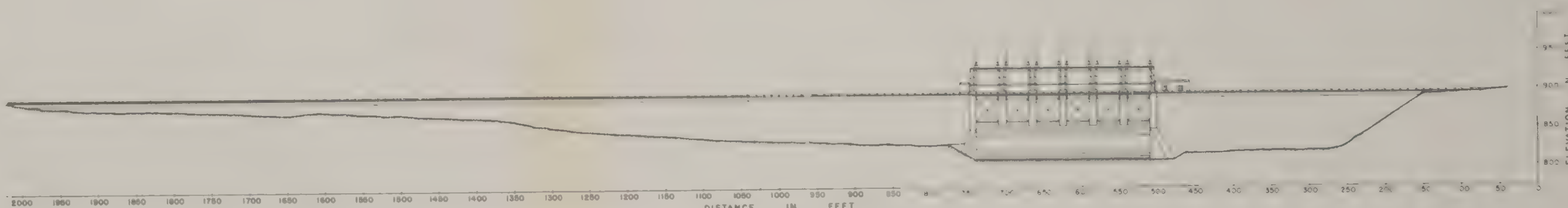
a General Description

The Fanshawe damsite is located on the North Branch of the Thames 5½ miles north of the city of London. The damsite area and reservoir limits were surveyed by the Department in 1945 and the construction of the dam and reservoir was recommended in the preliminary report. Subsequently the firm of H. G. Acres and Company was retained to prepare the plans and the dam is now under construction.

The dam will be of the gravity earth-fill and concrete type. The concrete spillway section will be 250 feet long, 100 feet high (above bedrock) and 115 feet wide at the base. The spillway will be fitted with two 6-foot diameter controlled discharge tubes and six 30 feet by 30 feet spillway gates and have a discharge capacity in excess of 100,000 c.f.s. at maximum water level. In addition the necessary water intake tubes and pumping equipment will be installed in order that the reservoir may be used for domestic water supplies for the city of London.

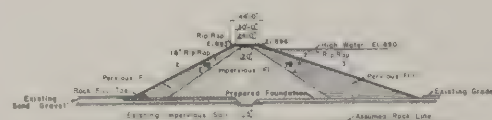


GENERAL PLAN OF EARTH FILL DAM & SPILLWAYS



DOWNSTREAM ELEVATION OF EARTH FILL DAM & SPILLWAYS

TYPICAL SECTION THROUGH SPILLWAY



TYPICAL SECTION THROUGH EARTH FILL DAM

FANSHAWE DAM

PLAN, PROFILE AND TYPICAL SECTIONS

SCALE — FEET

50 0 50 100 150

FIG. H-6

▲ FANSHAWE DAMSITE, *Summer 1947—looking upstream from road between Cons. III and IV London Twp.*

▼ GLENGOWAN DAMSITE—*from bridge on Lot 7 Con. XV Blanshard Twp. Broken white line in this and following photographs indicates (approx.) the crest of the proposed dam.*

The earthen embankments which will join the concrete section to the valley slopes and complete the barrier will have a minimum top width of 44 feet with 3 to 1 and 2 to 1 slopes on the upstream and downstream sides respectively. Total length of the completed structure will be 2,050 feet.

The reservoir when full (elevation 890 feet) will have a water surface area of 1,322 acres, extend northerly for approximately 7 miles, with a maximum depth of 71 feet at the dam and a storage capacity of 38,880 acre feet. At the proposed recreational lake level (elevation 860 feet) the reservoir will extend northerly for a distance of 4.4 miles, with an average width of 1/4 mile and a maximum width of 1/2 mile just north of the dam. The water surface area will be 645 acres and it will have a volume of 10,040 acre feet.

A plan showing the general arrangement of the dam is shown in Figure H-6. The estimated cost of the dam and reservoir including a 24-foot roadway along the top of the dam and the development of the supplementary recreation facilities is $4,711,250.

b The effect of its use as a recreational lake

When a reservoir is used as a recreational lake there is no storage retained for increasing low flows. The water level in the reservoir would be lowered to the fixed lake level as soon as possible after the flood period in order to preserve vegetation, and regulated approximately at that level throughout the following months; otherwise wide fluctuations in water levels would not satisfactorily serve its recreational purpose. The Fanshawe Reservoir therefore will make no contribution in increasing low flows.

(2) Glengowan Dam and Reservoir

The Glengowan site is located on the North Branch three miles north of the town of St. Marys. The survey of the reservoir area and foundation investigations have been carried out and a design of the dam prepared by G. Graham Reid, Consulting Engineer.

The dam will be the same type as the Fanshawe Dam, consisting of a concrete spillway section and earthen embankments. The spillway section will be 280 feet long and will be fitted with five sluiceways and six Taintor type gates each 8 feet high by 40 feet in length. The over-all length of the dam will be 1,200 feet with a maximum height of 64 feet above the bed of the river.

The reservoir, when full, will have a maximum depth at the dam of 59 feet, and the lake would extend northerly for a distance of about 8.7 miles with an average width of about 1/4 mile and a water surface area of 1,195 acres. With a reservoir capacity of nearly 27,000 acre feet it will provide protection to St. Marys for most flood years and would benefit all the municipalities down stream by reducing the high spring flows and providing increased summer flow.

The total estimated cost of this dam and reservoir, including a roadway over the dam, is $2,020,000.

(3) Wildwood Dam and Reservoir

This reservoir is located on Trout Creek near Highway No. 7. The foundation investigations have been completed and a design for the dam prepared by G. Graham Reid, Consulting Engineer. However, since this work was done subsequent calculations and further studies have indicated that a higher dam to provide greater storage is required at this point to give the needed protection for St. Marys and points below.

The proposed dam would be of the same design as that prepared by G. Graham Reid, but the height would be increased from 41.0 feet to a height of 53.0 feet above the bed of the stream. The reservoir for this higher dam would extend south-easterly from the dam for a distance of 6.2 miles with an average width of 1,170 feet and a surface area of 880 acres. The maximum holding capacity of this reservoir would be 14,900 acre feet as compared to 6,400 acre feet for the original dam.

▲ WILDWOOD DAMSITE—*looking upstream from No. 7 Highway 2 miles east of St. Marys.*

▼ THAMESFORD DAMSITE—*panorama of the proposed site 2 miles north of Thamesford Lot 5 Con. XI Nissouri E. Township.*

This dam would also be of the earth-fill and concrete type and would be fitted with five gate-controlled rectangular orifices and 108 feet of free overflow section to provide satisfactory regulation of the discharge from the dam at all times.

The estimated cost for the dam and reservoir is $1,407,000.

(4) Thamesford Dam and Reservoir

The Thamesford Reservoir site is located on the Middle Branch two miles north of the village of Thamesford. The damsite for this reservoir would roughly coincide with the line between Lots 4 and 5, Concession XI in the Township of Nissouri East.

This site is suitable for a dam 49.5 feet in height which would provide 17,500 acre feet of storage. Such a dam would create an artificial lake 6.4 miles long with an average width of 1,550 feet, a surface area of 1,200 acres and a maximum depth of water at the dam of 43.5 feet.

Several bridges and road crossings would be flooded out by this proposed dam, but this site is the only one on the South or Middle Branches which can provide a reservoir of appreciable size and the site should therefore be developed to its maximum for flood control and conservation purposes.

No foundation investigations have been carried out at this site as yet, but the estimated cost of the dam and reservoir based on an assumed depth to rock of 25 feet is $2,440,000.

(5) Woodstock Dam and Reservoir

This dam and reservoir would be located on the South Branch immediately north of the city of Woodstock. The damsite would be located about 1/2 mile east of No. 19 Highway between Lots 20 and 21, Concession XII, Zorra East Township. This would be a low dam 31 feet in height, being limited by the Canadian Pacific Railway which skirts the southerly side of

the proposed reservoir area. When full the reservoir would extend north-easterly from the dam for a distance of 4.5 miles, with a width of about 1,050 feet, a surface area of 575 acres and a maximum water depth at the dam of 25 feet.

The capacity of this reservoir would be 5,152 acre feet, and being situated so closely to the trouble area it could be used to full advantage during the critical periods of high flow.

This reservoir is ideally located for a recreational lake and if it should be required for this purpose at some future date the conservation storage so lost could be replaced by constructing one or two small dams farther up stream.

The estimated cost for this dam and reservoir is $760,000.

(6) Cedar Creek Dam and Reservoir

The dam for this reservoir would be located on the Cedar Creek 1 1/2 miles south of the city of Woodstock and would be the smallest dam in the proposed reservoir system. The dam would be of the earth-fill and concrete type 27.5 feet high and 1,100 feet long and would control the run-off from some 31 square miles of drainage area lying south of Woodstock.

The reservoir, at full capacity, would have a water surface area of 1,460 acres and would be the largest of any of the proposed reservoirs in this respect. Actually it would be two separate lakes joined together by narrow channels a short distance above the dam. The southerly lake or arm would extend back from the dam a distance of 3 miles with a water surface area of 600 acres, and the easterly lake or arm would extend eastward from its confluence with the southerly arm a distance of about 2.5 miles, with a water surface area of some 860 acres. A large part of the flooded lands is swamp which has little value except for storing water.

WOODSTOCK DAMSITE—*panorama of the proposed site immediately north of the city, Lot 21 Con. II Blandford Township.*

CEDAR CREEK DAMSITE—*looking downstream from bridge on road between Cons. II and III Oxford E. Township.*

This reservoir would have a storage capacity of 7,728 acre feet with a maximum depth of water at the dam of 21.5 feet. With this amount of storage this project, in conjunction with the Woodstock Reservoir and Channel Improvement, would provide the needed protection for Woodstock and also provide a valuable increase for the much needed summer flows in the South Branch. Further, this is one of the few natural sites available on the South Branch and steps should be taken immediately to obtain these lands before the area becomes too built-up and the land values make the construction of a reservoir in this area too costly.

The estimated cost of this dam and reservoir is $604,000 or approximately $78.00 per acre foot, which is the lowest per acre foot cost of any reservoir on the watershed.

(f) Other Dams and Reservoirs

Eight reservoir areas were surveyed in the watershed, of which six have been selected to make up the reservoir system for flood control and water conservation storage. The two remaining sites, namely Medway and Fish Creek, are good sites and are the only remaining ones where sufficient storage capacity may be had to make the construction of a dam economically feasible. These sites should be held in reserve in the event that some unforeseen conditions make the provision of additional storage in the system advisable or necessary.

(1) Medway Dam and Reservoir

The Medway damsite is located on the Medway River about 3 miles north-west of the city of London. The Medway drains an area of approximately 75 square miles of which about 73 square miles could be controlled by a dam at this site.

A 76-foot dam could be constructed at this point to impound about 21,500 acre feet of water, which would provide useful flood control for the city of London. The reservoir is located too far down the watershed to be used as a dual-purpose reservoir and the cost cannot be justified by flood control alone at the present time.

(2) Fish Creek Dam and Reservoir

The Fish Creek damsite is located on Fish Creek $5\frac{1}{2}$ miles south-west of the town of St. Marys.

This site is suitable for a 41-foot dam which would impound 11,500 acre feet of water and control the run-off from 58 square miles of drainage area. This amount of storage would be most useful should one of the reservoirs above St. Marys be required for a recreational lake or should additional summer flow be required on the North Branch.

Table H-B below gives the data and costs for all the dams and reservoirs included in the proposed scheme, together with the dam and reservoir data for the above two reservoirs which were surveyed but which are not included in the reservoir system. Additional dam and reservoir data is given in Table H-5 at the back of this section of the report.

TABLE H-B

DAM AND RESERVOIR DATA

Name	Dam		Reservoir				Cost
	Length (Ft.)	Height (Ft.)	Length (Miles)	Av. Width (Ft.)	Area (Acres)	Capacity (Ac. Ft.)	$
Glengowan	1,200	64.0	8.7	1,132	1,195	26,954	2,020,000
Wildwood	1,790	50.5	6.2	1,170	880	14,900	1,407,000
Fish Creek x	980	41.0	7.7	1,054	984	11,753	-
Fanshawe	2,050	77.0	7.6	1,469	1,351	38,880	4,711,250
Medway x	950	76.0	5.2	1,560	983	21,507	-
Woodstock	1,440	31.0	4.5	1,052	575	5,152	760,000
Cedar Cr.	1,100	27.5	5.5	2,185	1,459	7,728	604,000
Thamesford	1,200	49.5	6.4	1,548	1,200	17,466	2,440,000
Totals						111,080	11,942,250

x Surveyed but not included in scheme.

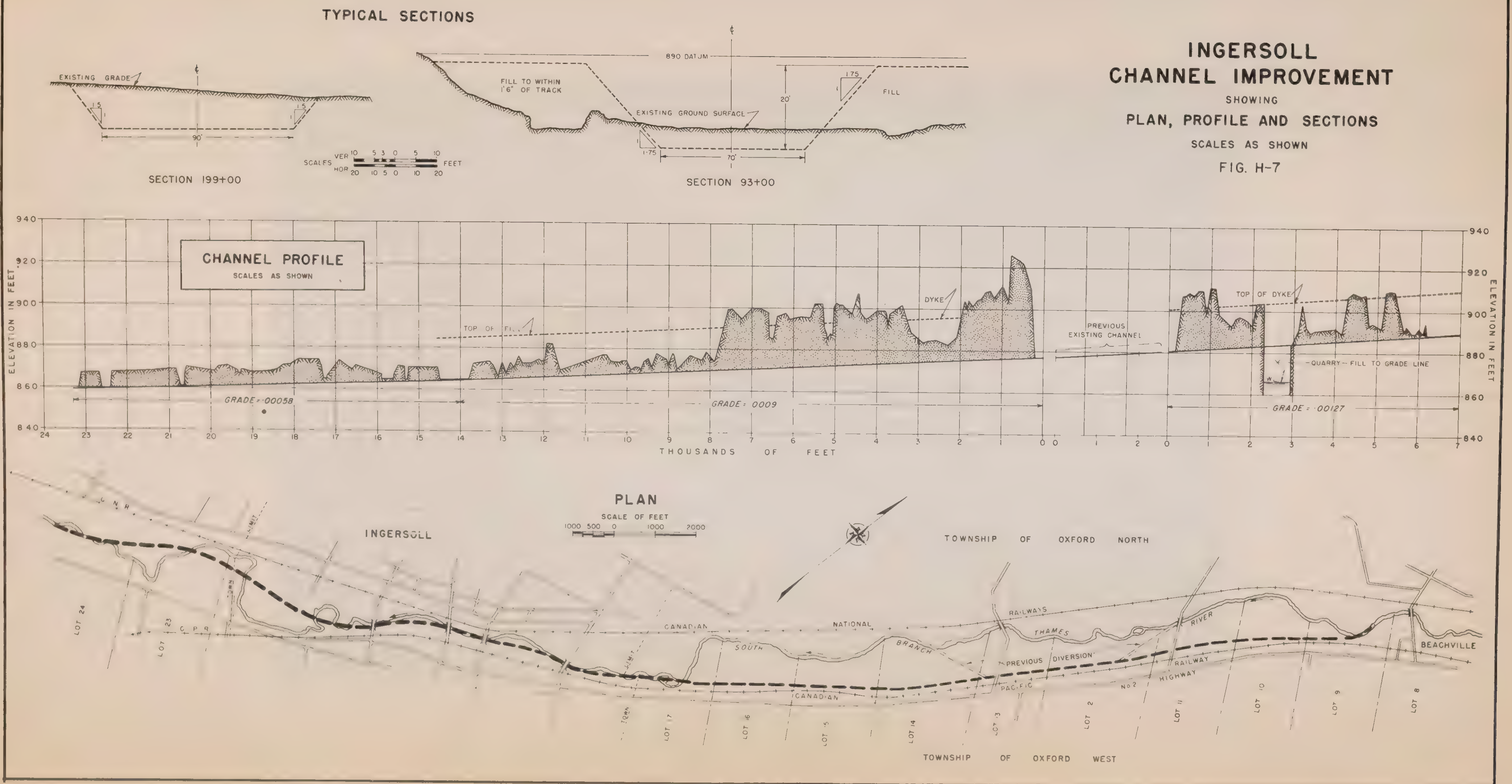
(g) Channel Improvements

(1) Ingersoll Channel Improvement Scheme (Fig. H-7)

In addition to the two conservation reservoirs which are proposed for the South Branch of the Thames River, an extensive channel improvement scheme designed and supervised by the firm of G. Graham Reid, Consulting Engineers, has already been completed. This is located in the Beachville-Ingersoll area and is known as the Ingersoll Channel Improvement Scheme. This work was done to provide immediate flood protection for the town of Ingersoll and the industrial plants and quarries located in the river valley above Ingersoll.

Starting at the village of Beachville the improved channel section parallels the Canadian Pacific Railway line along the southerly side of the valley to the easterly limit of Ingersoll. From this point the new channel follows, in general, the natural river course except for the wide loops below Ingersoll which it cuts through. The length of the new channel is 32,725 feet, as compared to 39,640 feet, the overall distance by the old channel. The new channel has a bottom width of 60 feet for the upper 14,000 feet, then a 70-foot bottom width for 6,500 feet and an 80-foot bottom width for the next 3,300 feet, increasing to a 90-foot bottom width for the remaining 8,925 feet. The side slopes are 1.75 to 1 vertical for the upper and central sections and 1.5 to 1 vertical in the lower part. The grade varies throughout, being 0.127 per cent for the upper part, 0.09 per cent for the central part and 0.058 per cent for the lower part.

Construction of this channel required the excavation of some 1,612,000 cubic yards of earth and about 26,000 cubic yards of rock. Most of the earth was used to raise the height of the banks and the stone for rip-rapping the side slopes. The consolidated earthen dikes built from the waste material have a minimum height of 20 feet above the bed of the channel with a minimum top width of 12 feet.



INGERSOLL
CHANNEL IMPROVEMENT
SHOWING
PLAN, PROFILE AND SECTIONS
SCALES AS SHOWN
FIG. H-7

—London Free Press

INGERSOLL CHANNEL IMPROVEMENT

Aerial view of the improved channel through Ingersoll taken from the north-west. Bridge at centre of photograph is the Thames Street Bridge.

The greatest known flow in this area occurred in April 1937. Unfortunately there was no gauge established at Ingersoll to record this discharge, but from the Ealing gauge it has been calculated that the maximum mean daily flow at Ingersoll during this flood was about 7,400 c.f.s. with a probable peak flow of 10,400 c.f.s. A stream gauge was established at Ingersoll in 1938 and flood discharges have been recorded since then. High flows for each year are shown below:

Ingersoll Gauge Readings 1938-50

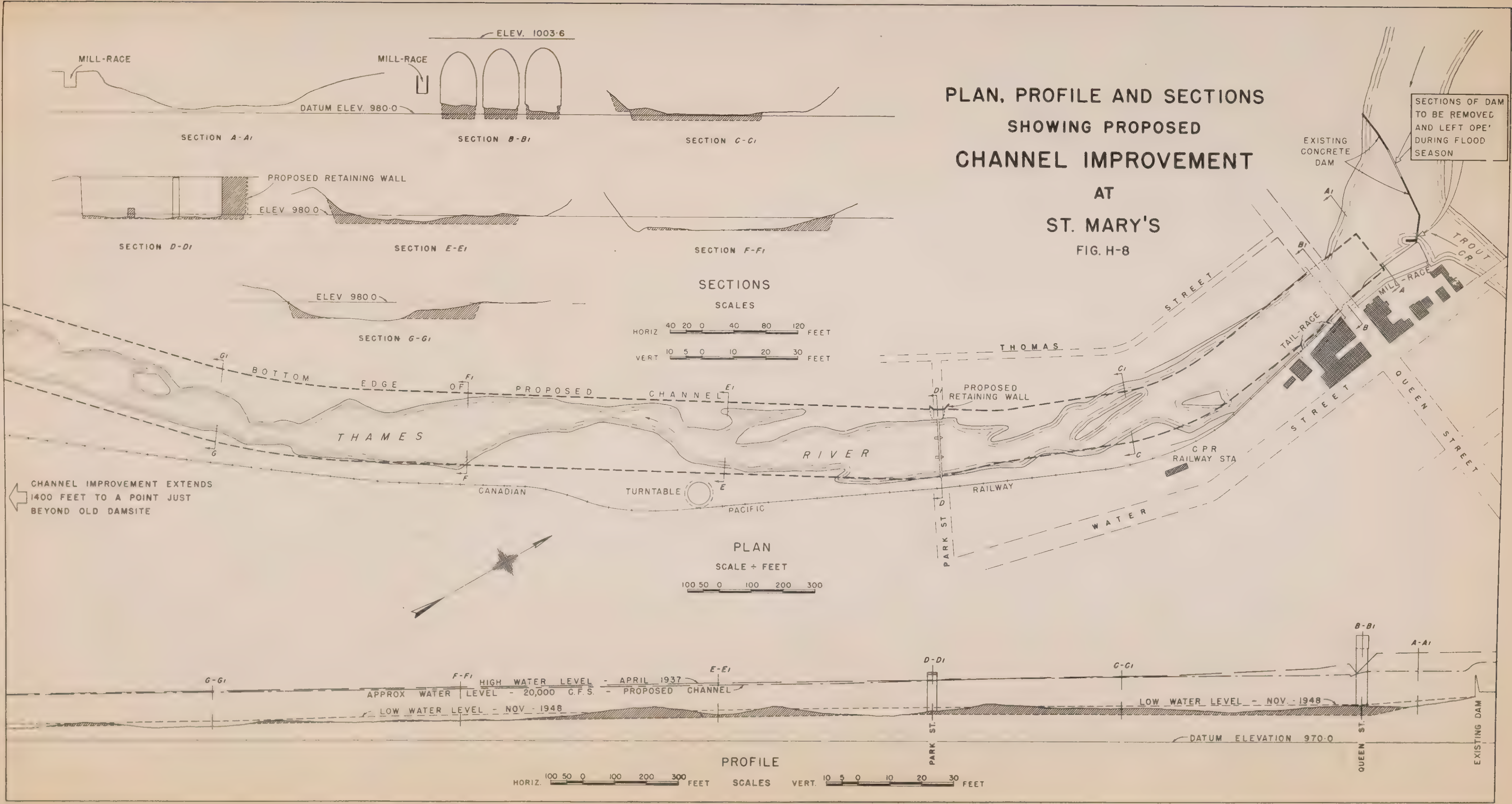
Date	Max. Mean Daily c.f.s.	Probable Peak Flow c.f.s.
1937 April (estimated)	7,400	10,400
1938 February 14	2,230	3,122
1939 April 19	1,810	2,534
1940 April 9	3,030	4,244
1941 April 6	403	564
1942 March 9	2,280	3,192
1943 February 24	2,500	3,500
1944 March 14	1,260	1,764
1945 March 7	1,420	1,988
1946 March 8	2,030	2,842
1947 April 6	3,460	4,844
1948 March 20	2,890	4,046
1949 February 15	2,700	3,780
1950 April 4	2,790	3,906

The new channel was designed to carry a flow of 8,000 c.f.s. and will safely discharge momentary peak flows as high as 11,750 c.f.s., which provides protection against such floods as have occurred in the past. However, the present flow capacity of the Thames Street Bridge in Ingersoll is only 8,650 c.f.s. and in the case of flows such as were experienced in April 1937 the water would be backed up for a short time at the height of the flood flow. However, this channel alone will provide sufficient flood protection for most years and, together with the two proposed conservation reservoirs, will provide for floods of the hypothetical magnitude.

The cost of the work, including a new bridge, was $1,000,000.

(2) St. Marys Channel Improvement Scheme (Fig. H-8)

The town of St. Marys is situated on the North Branch of the Thames at the confluence of Trout Creek 22 miles



PLAN, PROFILE AND SECTIONS SHOWING PROPOSED CHANNEL IMPROVEMENT AT ST. MARY'S

FIG. H-8

north of the city of London. The combined watersheds of the two streams have a drainage area of 416 square miles at this point, being comprised of 352 square miles for the North Branch and 64 square miles for Trout Creek. The area above St. Marys is flat and intensively drained. There is very little forest cover and these factors together with the steep stream gradients all contribute to a quick run-off from the area and the consequent fluctuations in the flows at St. Marys.

A gauge was established at the Park Street bridge in St. Marys in 1938 and the high spring flows have been recorded for each year since. The highest mean daily flow recorded was 11,800 c.f.s. on March 20, 1948. The peak flow on that day from timed records was 18,668 c.f.s. However, many local residents claim that the 1937 spring flood was greater than that of 1948. This flood occurred before the gauging station was established and the daily flows during the flood period were not recorded. From the Fanshawe gauge records it has been estimated that maximum mean daily flow for the 1937 flood was 15,220 c.f.s. with a corresponding peak flow of 20,240 c.f.s. In the case of a flood of the hypothetical magnitude a maximum daily flow of 23,632 c.f.s. with a corresponding peak flow of 31,500 c.f.s. might be expected.

The overall water conservation plan for the Upper Thames Watershed provides for the construction of two storage reservoirs above St. Marys (Glengowan and Wildwood) with a combined storage capacity of 41,854 acre feet of which 38,854 acre feet would be available for flood control purposes. This amount of storage would provide protection from floods such as have occurred in the past but would not be sufficient for the hypothetical flood; consequently some channel improvement would be necessary to supplement the storage and satisfy the flood problem.

It is estimated that the present channel through St. Marys can only accommodate flows up to 10,400 c.f.s. and still provide a margin of safety. To reduce the hypothetical

St. Marys Dam—present dam has not sufficient spillway capacity to discharge the high spring flows safely.

Queen St. Bridge—limited opening at this bridge further aggravates the flood conditions.

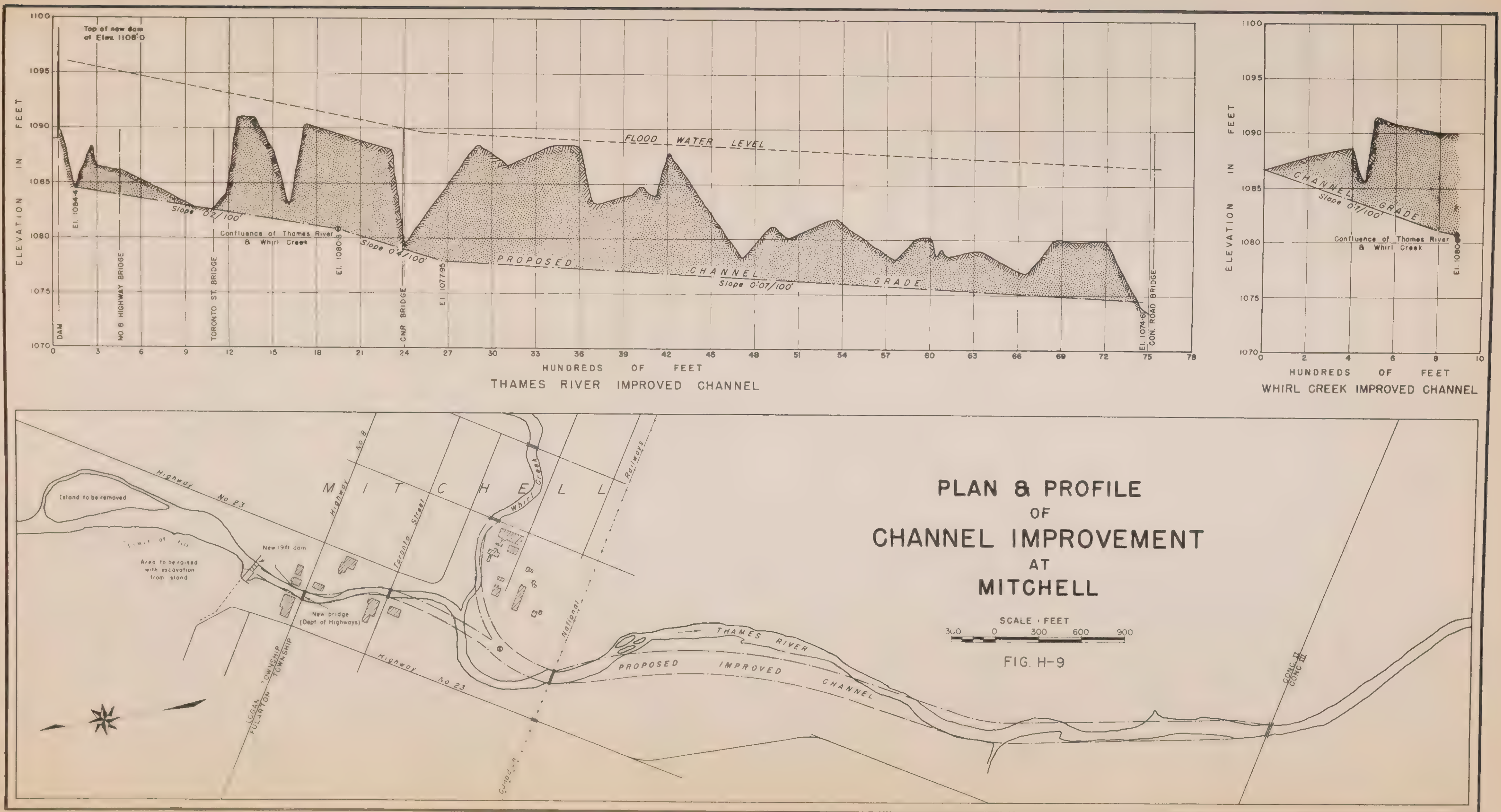
River channel north of Park St.—shoals and weedy condition of the stream bed also tend to impede the normal passage of the spring flows.

maximum mean daily flow to this stage would require 57,300 acre feet of storage or 18,400 acre feet more than is available in the proposed Glengowan and Wildwood reservoirs. Thus to give full protection to St. Marys additional storage or an increased channel capacity is necessary. The additional storage could be made available by constructing a third dam above St. Marys, but in view of the fact that the present proposed storage is sufficient for the overall flood and low flow problems it is believed that the channel improvement offers the better solution. Further, in order to make full use of the channel capacity at London and to be able to route the flood waters to the best advantage, St. Marys should be able to discharge its proportion of channel capacity flow or at least 12,100 c.f.s. This flow is 1,700 c.f.s. more than the present channel can safely handle and thus some channel work would be required in any case.

Flood relief for St. Marys is an urgent matter and, as it would probably be some time before the reservoir system would be in operation, it is recommended that the channel improvement work be extended to provide protection against floods up to the magnitude of the 1937 flood or a flow of 20,000 c.f.s. However, in recommending this amount of channel improvement two facts have been kept in mind. Firstly, that this work is only a temporary measure to provide some immediate relief for St. Marys and the amount of work has therefore been kept to a minimum wherever possible in order to avoid unnecessary expenditures. Secondly, that the pond behind the present dam has a certain aesthetic and recreational value and the proposed work has been designed to leave most of the dam intact so that the pond may be restored at a minimum cost.

The estimated cost for this channel improvement is $135,000.

This cost does not provide for restoring the pond above the dam for recreational or power purposes. If the pond is wanted for the summer months then removable timber dams



PLAN & PROFILE
OF
CHANNEL IMPROVEMENT
AT
MITCHELL

FIG. H-9

per square mile. During the summer months the flow is reduced to a mere trickle and in many cases stops altogether. Such extremes in flow have caused much distress and inconvenience to everyone along the river. The floods have caused damage to dams, roads, bridges, buildings and crops and the lack of flow has deprived the town and adjacent countryside of a valuable water supply and of the potential recreational features of the river. Further, such conditions seriously interfere with the disposal of sewage and industrial wastes and present a threat to the health of the community.

While flooding is the major problem at Mitchell and the immediate objective is to control the high spring and flash summer flows, any remedial measures which do not provide for an increased summer flow could not be considered to be complete.

Conservation storage reservoirs would satisfy both phases of this problem. Unfortunately, there are no reservoir sites of economical size available above Mitchell. The present dam at Mitchell could be raised five feet and the pond area dredged to contain some 1,200 acre feet of storage, which would ease the flooding somewhat and provide means for a definite improvement in the summer flow.

This amount of storage situated so close to the trouble area would be invaluable in times of flooding but would not be nearly enough to give complete protection against even such floods as have occurred in the past. Thus other supplementary works are necessary. The required protection could be had by either increasing the channel capacities of the streams through Mitchell or by diverting the Whirl Creek flow around the town. Of these two methods the channel improvement is the better and is the one recommended.

The channel improvement work would consist of removing obstructions such as islands and shoals, deepening, widening and straightening the river channel from the dam to a

Highway Bridge at Mitchell—a new bridge with a 75-foot clear span would be erected here.

Mitchell Dam. This dam would be removed and replaced by a dam 5 feet higher.

Looking downstream from the dam—the river has been confined to its low-water channel by buildings, retaining walls and narrow bridge openings.

point about one mile below the town. The improved channel would vary in bottom width from a minimum of 60 feet above the confluence of Whirl Creek to a maximum of 160 feet below the Canadian National Railway bridge. In addition, a concrete wall would be built at the Flax Mill to protect the mill building and the No. 8 Highway bridge would be replaced by a new bridge with a clear span of 75 feet. The Whirl Creek channel would be graded to a uniform slope and section with a bottom width of 35 feet and side slopes 1½ to 1 from its mouth up stream for a distance of 570 feet. The Whirl Creek channel would also be aligned at the confluence to allow the two flows to come together smoothly, thus permitting a freer passage of the flood waters at this point and minimizing the backwater effect.

The additional storage being provided at Mitchell will more than compensate for the water which will be hurried through by the improved channel section and should prevent any appreciable increase in the flood flows below the town, and the increased summer flow which would be made available would benefit many along the river from the dam on down.

The plans and profiles for this proposed work are shown in Figure H-9. The ground surveys, flood investigation plans and cost estimates were made by the Kilborn Engineering Company Limited upon instructions from the Upper Thames River Conservation Authority. The above proposal is their recommended method for flood control and improved summer flow and is approved by the Department.

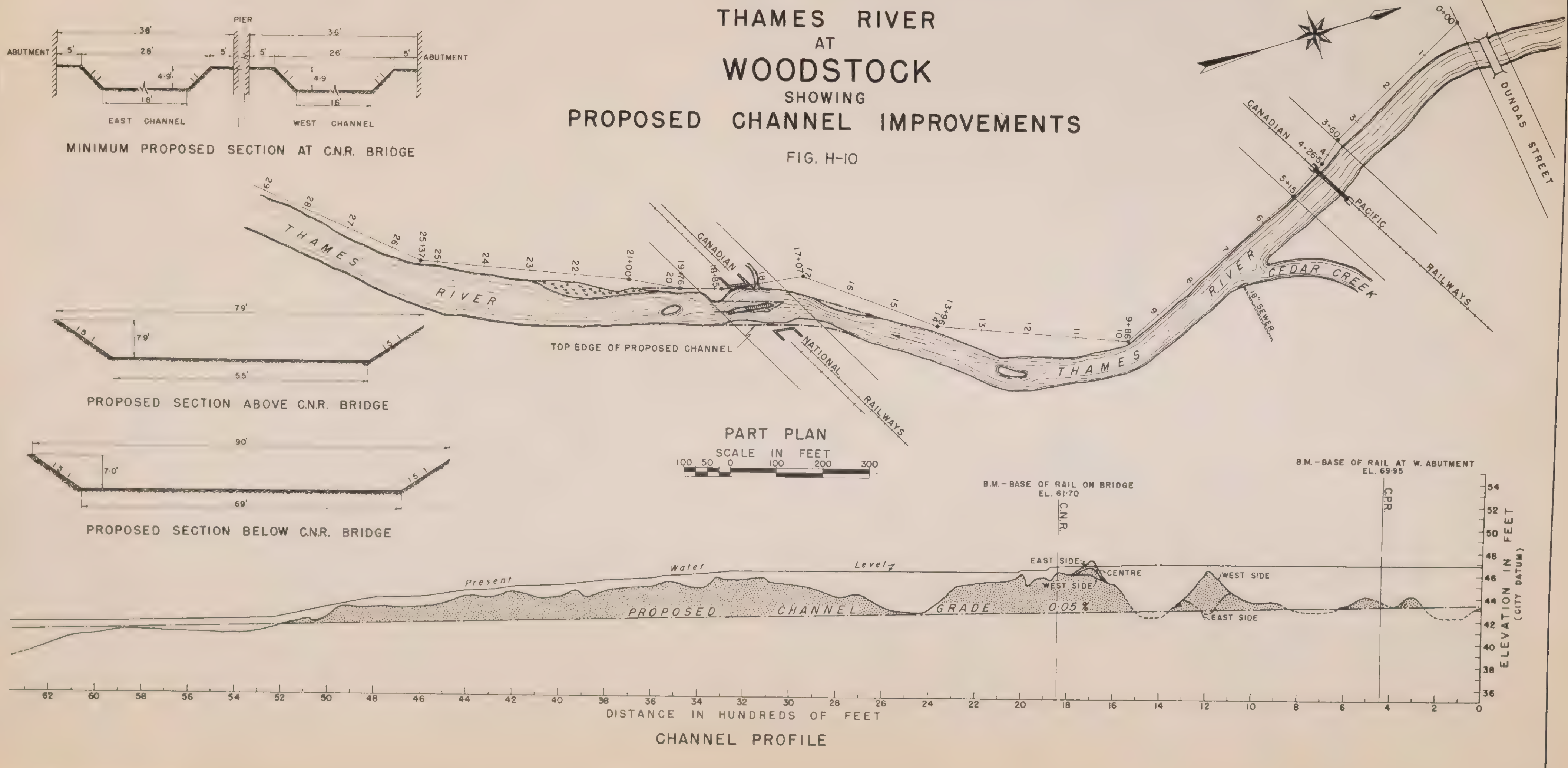
The estimated cost of the dam and channel improvement is $260,000.

(4) Woodstock Channel Improvement (Fig. H-10)

Flooding at Woodstock is caused by solid limestone rock shoals, which in places rise in the river bed, from Dundas Street for nearly a mile down stream. The shoals choke the flood flows and cause a backwater on the Thames River and up Cedar Creek where most of the damage occurs. Even with the

THAMES RIVER
AT
WOODSTOCK
SHOWING
PROPOSED CHANNEL IMPROVEMENTS

FIG. H-10



shoals removed the channel is not large enough to contain major floods, but their removal, together with the Woodstock and Cedar Creek reservoirs, will provide protection against a flood of the hypothetical magnitude.

A channel capacity of 1,355 c.f.s. requires 18,300 acre feet of storage above Woodstock for the hypothetical flood. The two reservoirs shown below and recommended elsewhere in this report provide the following storage:

Woodstock Reservoir	5,152	acre feet
Cedar Creek Reservoir	7,728	" "
Total storage	12,880	" "
Storage required	18,300	" "
Storage deficiency	5,420	acre feet

With both reservoirs in operation the 5,420-acre feet storage deficiency would require a channel capacity at the confluence of the South Branch and Cedar Creek of 2,000 c.f.s. for the hypothetical flood and it is proposed to excavate and grade the river in order to increase the channel capacity from 1,355 to 2,000 c.f.s. The cost of this work is estimated at $75,000 if completed during a period of low water.

TABLE H-C

CHANNEL IMPROVEMENT DATA

Name	Length Feet	Bottom Width Feet	Cost $
Ingersoll	32,725	60 to 90	1,000,000
St. Marys	5,960	150 to 225	135,900
Mitchell	7,500	60 to 160	260,000[1]
Woodstock	5,900	55 to 69	75,000
Total			1,470,900

1. Including cost of small dam.

4. Hydrology of the Upper Thames River

(a) Hydrometric Gauges and Records

The storage required for the hypothetical spring flood has been determined from the records of the hydrometric

gauges which in past years have been installed in the river and which will be hereafter referred to as "gauges".

Gauges are rods graduated in feet, tenths and hundredths of a foot which are installed at a section of a river, whereby, with a rating curve prepared from flows determined for various stages of the water level of the river, flows or discharges of the river at the gauge are known approximately for any reading on the gauge. The gauges in general are of two types: automatic, with which time and gauge heights are graphically recorded on a chart, and staff gauges which are read by observers, usually twice daily and oftener during flood periods.

This service is administered and the records published by the Water Resources Division, Ottawa (formerly called the Water and Power Bureau[1]). Table H-6 gives the names, drainage areas and period of records for all the gauges on the Upper Thames River and also shows the drainage areas for the main tributaries, places and damsites.

The published records do not show the time of recorded flows but show an average flow for each day which is called "mean daily" flow. It may be pointed out that although the records show that the maximum mean dailies for the North and South Branches coincided on many days, their peaks however may have been several hours apart. There may have been occasions when the peaks of spring freshets coincided at the Forks, but if so there is no mention of it in the published records.

The Hydro-Electric Power Commission began installing gauges in the rivers of Southern Ontario in 1910 and continued setting them up and operating them until 1919 when this service was taken over by the Bureau. Both the Hydro and the Bureau were interested only in those rivers which had power possibilities, and for this reason many of the gauges which had been set up were discontinued after a few years of

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1. For brevity hereafter called the "Bureau".

operation. The flashy rivers which have a high rate of run-off during the spring freshet, causing floods followed by extremely low flows during the summer, have little power potential, and for this reason gauges were not installed in most of these rivers until 1945 when they were set up by this Department at its inception. Gauges were installed however at Ealing on the South Branch and at Fanshawe (transferred to Western University in 1944) on the North Branch in 1915 and fortunately have continuous records to date. Also a gauge was set up in 1914 on the main stream below London at Kilworth bridge, which was transferred to Byron in 1922. Byron gauge was discontinued in 1932 and resumed in 1938 for the spring months only.

There are now nine gauges in operation on the Upper Thames Watershed. The locations of the gauges are shown on Fig. H-5 and their rating curves in Figs. H-11 and H-12.

(b) Run-Off and Run-Off Ratios

Run-off is the amount of water that the drainage area supplies to the open stream and is the excess of precipitation over evaporation, transpiration and deep seepage.

The amount of run-off varies greatly with the classification and condition of the soil and is less than 10 per cent of the precipitation on dry sandy soils, to 90 per cent or more in the spring with frozen clay, ice or rock. The run-off of a drainage area above a gauge is expressed as a rate in c.f.s. per square mile and may be determined by the equation

$$\text{c.f.s. / square mile} = \frac{\text{c.f.s.}}{\text{Drainage area in square miles}}$$

With flood and low flow problems it is the extreme conditions which may occur that have to be considered, and for reliable values, hydrometric records of 20 years or more are necessary. The Western and Ealing gauges have long-term records and provide the data for the London flood problem. However, the rate of run-off varies over the watershed and the London gauges alone could not be used by the direct proportion of drainage areas to

determine flows at St. Marys, Mitchell and Woodstock unless reliable adjustments were made for differences in geophysical and climatic conditions, a method which is sometimes necessary but gives results which are only approximate.

The short-term gauge records (six years) at or near the trouble areas above London can be used and a satisfactory rate of flow determined for those places by establishing run-off ratios between the years of the short-term and the corresponding years of the long-term records.

Table H-D shows the run-off ratios of the short-term gauges relative to the Western University and Ealing gauges. The ratios were determined by comparing the volume of flow for an eleven-day period for each year of the short-term records with the volume of the corresponding flood period of the long-term records at London, the run-off ratios being:

$$\frac{\text{The volume of 11 days spring flood flow at the short-term gauge}}{\text{The volume of 11 days spring flood flow at the long-term gauge}}$$

The weighted average of the six ratios for each of the short-term gauges gives a ratio which may be applied to any rate at Western University and Ealing gauges at London.

TABLE H-D

FLOW RATIOS RELATIVE TO WESTERN UNIVERSITY AND EALING GAUGES

Ratios determined from the Max. mean daily and the flow volume over the flood periods for the available years of record

Ratios Relative to Western University Gauge Drainage Area - 657.2 sq. miles			
	Ratio		
Gauge	Drainage Areas	Volume for Flood Period	Max. Mean Daily for Period
St. Marys	0.63320	0.66308	0.60785
Fish Creek	0.08780	0.06845	0.05700
Trout Creek	0.08308	0.06619	0.09165
Medway	0.10620	0.11712	0.10800
Ratios Relative to Ealing Gauge Drainage Area - 519.1 square miles			
Ingersoll	0.41290	0.39247	0.33520
Thamesford	0.22650	0.31588	0.33975

(c) The Hydrograph

> "[1]The Hydrograph is a correct expression of the detailed run-off of a stream, resulting from all the varying physical conditions which have occurred on the drainage area above the gauging station previous to the time which it represents."

It is by means of the hydrograph that the volume of storage herein is determined. Figs. H-13 and H-14 show continuous hydrographs for all the years of records for the Western University and Ealing gauges.

Fig. H-15 shows on a larger scale hydrographs for the major spring floods of record. The vertical measurements represent c.f.s., and the horizontal measurements time. The area of the hydrograph for any period of time represents the volume of water which has passed the gauge. In order to avoid the use of astronomical numbers, volume is expressed in acre feet[2] instead of cubic feet.

Flood hydrographs are roughly triangles or a series of triangles rising from and receding to the normal or base flow. The left limb (the rising or accession limb) rises from the base flow to the maximum mean daily or the apex of the triangle. Actually, for timed flows the apex is not a point but is slightly blunted or rounded. When at the apex, all of the surface run-off has reached the river and the right limb (the falling or recession limb) represents the lowering of the "valley storage" or the falling stages of the water level of the river until it is down to base flow. The rising and falling limbs are slightly concave but may be assumed as straight lines and the apex assumed as a point in calculations without serious error. The interval of time between base flows is the "flood period".

(d) The Hydrograph for a Hypothetical Spring Flood

When hydrometric records are available the amount of storage that would be required to control any particular

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1. Definition given in "Hydrology" by Professor D. W. Mead.
2. One c.f.s. flow for one day = 1.98347 acre feet or approximately 2 acre feet per day.

flood in the past is not a difficult problem. For a future or "hypothetical flood", however, having a greater magnitude than any known flood, the problem becomes extremely complex and particularly so with ice and snow conditions at the time of the spring break-up. Under these circumstances there is no means whereby storage may be determined with mathematical certainty. There are various approaches to the problem but all are approximations. Methods used are:

(i) The unit hydrograph method, which is a correlation of hydrometric and meteorological records. At the present time this method is considered by American hydrologists to be the best approach. Their flood problems however are caused chiefly by rain, and this method is not so well adapted to our widely variable conditions of the ground, temperature, snow, ice, and rain.

(ii) The frequency curve whereby, with 20 or more years of hydrometric records, from a curve developed by the theory of probability, extrapolated values for a maximum run-off for a period of once in 50, 100 and up to 2,000 or more years may be determined. As a matter of interest frequency curves were prepared for the North and South Branches at London (Fig. H-16) and they show that the hypothetical spring flood flows would occur but once in about 450 years on the North Branch and about once in 200 years on the South Branch.

These curves, however, are fallacious and the best that may be said for them is that they are a hoped-for indication. They are based on the "law of averages", but floods do not follow that law, as is evidenced by the frequency and increased magnitude of floods in the last decade, due possibly to a change in climatic conditions. Isolated freak floods are also a possibility which upsets the theory. According to the frequency curve the South Branch, as for a maximum mean daily, had a flood in the spring of 1937 which should not occur again for 350 years.

(iii) With 20 years or more of records, a run-off graph for spring freshets showing maximum mean daily flows against total run-off between base flows may be developed. By increasing the maximum run-off by one-third or more the corresponding mean daily flow and total run-off for a possible future flood are determined.

When hydrometric records are available over a period of 20 years or more, many hydraulic engineers consider from 1-1/3 to 1-1/2 times the greatest rate of run-off for that period is safe to use as a maximum. With 36 years of hydrometric records, many of which record major floods, it is believed that the construction of a hydrograph at the gauges for the hypothetical spring flood based on the run-off graph using a factor of 1-1/3 will give the best answer to the storage problem. The construction of these hydrographs is based upon three concepts which will be compared with flood hydrographs of record and shown to be logical:- These concepts are:

(1) That the hypothetical hydrograph is approximately triangular in shape.
(2) That the flood period or the base of the triangle may be determined approximately.
(3) That the maximum mean daily or the apex of the triangle may be determined approximately.

(1) Hypothetical hydrograph is approximately triangular in shape

An examination of the hydrographs in Fig. H-13 and Fig. H-14 for the summer storms of June 1922, August 1926, July 1927, and July 1945 for the Fanshawe and Ealing gauges shows that they are definitely triangular in shape. With summer storms, where the hydrographs have been broken and have two or more apexes, the cause may be traced to a break in the storm or to an unequal distribution of rainfall.

During the spring run-off period it is ice jams, intervals of freezing temperatures, or rain which cause breaks in the hydrograph. If there were no ice jams or heavy rains and the temperatures remained above freezing there would be no

halt in run-off and the hydrograph would be continuous, having only one apex, excepting the case of major tributaries which may break up before or after the main stream.

Prolonged freezing intervals during the spring break-up lower the stage or water level in the river providing "channel storage" capacity, extend the time of the run-off period allowing the snow and ice to dissipate slowly and reduce the flood crests to lower levels or stages than would be the case with no freezing intervals and only one flood "run" or one apex. Fig. H-17, a hydrograph of the 1945 spring run-off, shows the influence of precipitation and temperatures on flood flows.

Since a definite volume of flow has been provided for the hypothetical flood period and one apex gives the highest rate of flow, therefore in theory an unbroken hydrograph or triangle would result in the highest peak for the given volume of flow.

Also if there should be a lag in the break-up of any of the major tributaries of the Thames such as the North, South or Middle Branches of the Thames, there would be a break in the hydrograph at the Forks. If the peaks, however, coincide at London there would be but one apex and the most adverse condition would be satisfied.

A flood period, however, of less magnitude than the hypothetical spring flood may have two peaks and cause a flood if the second peak or run has not been anticipated and space provided in the reservoirs for the second run. The soundness of the single triangular hydrograph is therefore contingent upon the reliability of meteorological forecasts and snow surveys prior to and during the spring flood period and all measures necessary for the efficient management and control of the dams.

Large ice jams, if they formed above a trouble area, could cause a break in the hydrograph and boost the flood peaks when the jam broke. The hydrograph for the hypothetical spring flood makes no provision for ice jams.

(2) Determination of the Base

An examination of the hydrographs of the flood periods at the Western University and Ealing gauges showed that the duration period did not vary greatly for summer storms, it being from 5 to 7 days only. With the spring floods, however, there is a wide spread from 7 days to as much as 24 days, but, as was pointed out in the previous sub-section, the long periods have been dissipated and have several minor peak flows. The major floods vary by only a few days; the pattern being that as the peak increases the duration of the flood period decreases, or in general the greater the flood magnitude the shorter the duration period, depending upon the breaks in the hydrographs. Eleven days is about the average duration for the major floods at these gauges. This is the duration period which is used in the next sub-section in preparing the run-off graph.

(3) The Run-Off Graph and Determination of the Apex or Maximum Mean Daily

The apex of the hypothetical hydrograph has been determined by means of a "run-off graph" (Figs. H-18 and H-19) which is a graphical correlation of the two variables, namely the volume of flow in acre feet and the maximum mean daily in c.f.s. for all of the spring flood periods of record. From these graphs the maximum mean daily or apex may be determined by extrapolation for the volume of flow which has been provided for the hypothetical spring flood period.

A study of the major flood periods showed that the duration at the London gauges varied between 10 and 12 days for the North Branch and from nine to eleven days for the South Branch. For the purpose of comparison three run-off graphs were prepared for the North Branch and three for the South Branch - 10, 11, and 12 days duration for the former and 9, 10 and 11 days for the latter. There was less than two per cent difference in the storage determined from each of the run-off graphs, a flood period of 11 days giving the greatest storage and the best result for both branches.

The run-off graphs were prepared as follows:-

(i) The area or volume of flow for the period was found by summing the flow records for each day and converting the result into acre feet. The volume for the flood period was plotted on cross-section paper relative to the maximum mean daily flow for the period, the volumes being to a horizontal scale and the maximum mean dailies to the vertical. All of the spring flood periods from 1916 to 1950 inclusive were plotted.

(ii) The arithmetic mean was determined for the volumes of all the periods and also for the maximum mean dailies, by their summation and dividing the results repectively by the number of periods. The arithmetic mean was plotted and a horizontal and vertical axis drawn through the point.

(iii) Moments were taken on both sides about the horizontal axis, the moment M = YQ, Y being the vertical measurement of the points to the horizontal axis and Q the volume for the period. The sum of the moments on each side of the horizontal axis were divided by the number of the periods on each side respectively. These two points A and B when plotted and joined by a straight line, the line passes through the arithmetical mean. Moments were taken in a similar manner about the vertical axis and the corresponding points C and D plotted. The straight line joining these points also passed through the arithmetical mean. These lines do not coincide but form an angle[1] at the arithmetical mean, due to the variable agencies which influence spring run-off.

(iv) The lines AC and DB were bisected at E and F respectively, which gives an average for the co-ordinates, and points on the line EF and EF produced are co-ordinates of a correlation between the maximum mean daily relative to any volume of flow for an eleven-day period.

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1. This angle is much smaller for summer storm periods than for those for spring run-off.

(e) The Maximum Mean Daily for the Hypothetical Spring Flood at the London Forks

(1) North Branch

The greatest flood on the North Branch occurred in April 1947.

The flow at London for 11 days was 206,562 acre feet and for the hypothetical flood amounts to 206,562 x 1-1/3 = 275,416 acre feet.

From Fig. H-18, the corresponding maximum mean daily flow for the hypothetical flood is 38,878 c.f.s. Figure H-20 shows the developed hydrograph for the hypothetical flood in the North Branch superimposed on the 1937 and 1947 flood hydrographs.

(2) South Branch

The greatest flood occurred on the South Branch in April 1937.

The flow at London for 11 days was 127,289 acre feet and for the hypothetical flood amounts to 127,289 x 1-1/3 = 169,719 acre feet.

From Fig. H-19, the corresponding maximum mean daily flow for the hypothetical flood is 20,700 c.f.s. Figure H-21 shows the developed hypothetical flood hydrograph superimposed on the 1937 and 1947 flood hydrographs.

From Figs H-19 and H-21, it will be noted that the maximum mean daily for the South Branch 1937 flood is slightly greater than that of the hypothetical flood. This great flood was exceptional for the South Branch drainage area, having been caused by heavy rain with a storm centre not far from Woodstock. 6.97 inches of rain was recorded at Woodstock between April 21 and 28, 3.37 inches of which fell in one day. Such a freak storm might occur again; if so, the storage provided by the increase in volume for the hypothetical flood would reduce peak flows to a safe stage at London. Figure H-22 shows the developed hydrographs for the 1937, 1947 and hypothetical spring floods at the Forks.

(3) Adjustment of the Base or Flood Duration

Using the determined area and altitude functions in the triangular hypothetical hydrograph and solving for the base gives a duration of:-

$$\text{base} = \frac{2 \text{ area}}{\text{height} \times 1.98347} \qquad \frac{2 \times 450560}{60302 \times 1.98347} = 7.534 \text{ days}$$

The triangle (Fig H-22) has been adjusted to conform to the 11-day period by extending the average base flow at the up and down limbs to 11 days and reducing the area of the triangle by an equal amount.

The similarity of the hydrographs in Figs H-20 and H-21 is noteworthy. They indicate that the triangular concept for flood periods is fundamentally sound. The storage which will be determined from the hypothetical hydrograph may not be absolute but it is believed to be a close approximation.

(f) Channel Capacity at London

The "channel capacity" for a place which is subject to flooding is the maximum flow in cubic feet per second which can be contained within the river channel without flooding. Expressed in another way, it is the highest stage or water level that the river can reach without overflowing its banks. Where dikes are proposed or already in place it may be related to some stage on the dikes.

A reliable "channel capacity" for each place flooded is essential for the solution of the flood problem at that place. If there is a rated gauge at the flooded area in question, the channel capacity flow can be determined at any time by relating the elevation of the overflow point with the same elevation of the gauge and the rate of flow for channel capacity determined from the gauge's rating curve. If the gauge is not too far away it may be obtained in the same way if the slope of the river or the difference in elevation is known between the gauge and the point of overflow. If the gauge is some distance away and the average rate of flow between the

points is known, it may be determined at flood time by having an observer at the flooded area and another at the gauge, each noting the time that the river reaches the "channel capacity" flow.

The Forks (Fig. H-5) is the critical point of overflow and tests were made for the channel capacity for London at that place during the spring flood periods of 1948 and 1950. Timed flows were observed at the Western University, Ealing and Byron gauges and were related to timed stages at the City of London's gauge at their Douglas Avenue Pumping Station which is located on the main stream about half a mile below the Forks. The gauge at Douglas Avenue is not rated and in order to determine a direct and absolute value for channel capacity and water level slopes between the Forks and the Douglas Avenue gauge, steps have been taken to have the river rated at the gauge and another gauge installed at the Forks. In the meantime the 1948 and 1950 tests have been used to determine the storage above London and, although tentative, it is believed that later tests will not show any substantial difference in the storage.

The right[1] bank of the North Branch from Oxford Street to the Forks and on the main stream to Douglas Avenue is protected by a continuous earth embankment, dike or breakwater with a concrete facing. The elevation of the top of the dike at the Forks is 774.0 feet[2].

The critical point of overflow is on the opposite side of the river at the junction of Dundas Avenue and James Street, the ground surface elevation being 770.0. From observations in 1948 by the City Engineer's Department, the Douglas Avenue gauge read 768.5 at the time when the river rose to the point of flooding at the Forks, with a water level slope at that time of 1.5 feet between the Forks and the gauge. This slope was used in both the 1948 and 1950 tests, allowance having been

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1. Facing down stream.
2. Geodetic Survey of Canada datum.

made for work done by the City in 1949 to ease this flow at the Forks; accordingly the channel capacity at the Forks is 35,670 c.f.s.

(g) Storage Required Above London

Space is provided in reservoirs for four independent purposes and the amount for each determined, viz:

(1) Channel capacity storage

(2) Dead storage

(3) Operational storage

(4) Boost discharge storage

(1) Channel Capacity Storage

The channel capacity storage above London is the equivalent of the volume of water which overflows at London. It is represented on the hypothetical hydrograph (Fig. H-23) by the area above the line 35,670 c.f.s., the channel capacity rate of flow. The triangular area above this line is

$$\frac{1.5385}{2} \text{ in.} \times 4.926 \text{ in.} = 3.7893 \text{ sq. in.}$$

1 square inch = 19834.7 acre feet

Therefore the channel capacity storage =

3.7893 sq. in. x 19834.7 = 75,160 acre feet

(2) Dead Storage

A reservoir is never drained bone dry. A certain amount of water is retained to protect the discharge tubes at the foot of the dam and to facilitate the silting of the reservoir bottom in the immediate vicinity of the dam in order to protect natural and artificial seals against damage. Dead storage space therefore is not used for flood control nor is the water available to supplement low flows at the end of a dry period.

The amount of dead storage depends upon the gradient of the bed of the reservoir and its width in the vicinity of the dam, and will vary for each reservoir.

The total amount of dead storage required is estimated (Table H-7) at 2,100 acre feet.

(3) Operational Storage

Operational storage is a cushion which will enable the control of the flows through London to approach but not exceed the channel capacity.

The following section on Water Conservation shows that from 48,000 to 50,000 acre feet of water should be stored in the reservoirs during the spring run-off period in order to increase and sustain the low flows which follow. If cheap storage were available this "conservation storage" for increasing low flows, reservoir space would be provided over and above that required for flood control and this part of the storage problem would be simplified. The cost of storage, however, on the Upper Thames, as with most watersheds in Southern Ontario, is very high and it is necessary to use the space in the reservoirs called "dual-purpose reservoirs" for both purposes, which means that during the spring flood period the controller of the dam system must operate them in a manner which will prevent a flood and at the same time fill the reservoirs to the conservation storage level, a very uncertain and exacting task. He has much worry at this time. He has to regulate the discharges of many dams, most of which are some distance upstream, time and route their discharges so that the flows through London (explained in the next section) will conform approximately to the hypothetical hydrograph and not exceed the channel capacity. He has to make provision for ice jams and regulate the dams in such a manner as to prevent flooding at the other trouble areas above London. His main concern, however, is the amount of snow cover, the condition of the soil and in particular what the weather ahead will be during and immediately following the spring run-off. It is assumed that, prior to the spring break-up, the condition of the soil will be known and that the average weight of snow pack for the various areas of the watershed will have been determined by field observers, from which the controller will know approximately the potential volume of run-off. What he

does not know is the behaviour of the snow melt, or if he will also have to contend with heavy rainfall. Meteorological forecasts are indispensable and future scientific research and more stations will enhance their dependability, but at the present time "No method of accurately forecasting the weather for more than 48 hours in advance has yet been devised that meets with the approval of the larger part of the meteorological profession"[1] whereas at least two weeks is required.

From the foregoing remarks it is obvious that during the spring run-off period the operator cannot control the flows at London, holding them at the channel capacity stage, but must have a lower stage to provide a margin of freeboard or a cushion below channel capacity, for an objective.

With the complexities of spring run-off and the above unpredictable agencies, it is not possible to determine the depth of freeboard by any analysis or mathematical means, and for the present, only an estimate based on considered judgment can be made. It is estimated that 9 inches or 0.75 feet of channel capacity freeboard is necessary. The flow at elevation 769.25 at the Forks is 31,725 c.f.s. and the triangular area above this line (Fig. H-23) is $\frac{1.785}{2}$ in. x 2.8577 in. = 5.101 sq. in. 5.101 x 19834.7 = 101,177 acre feet. The operational storage = (101,177 - 75,160) = 26,017 acre feet. From Fig. H-23 it will be seen that an inch of freeboard below channel capacity averages $\frac{130,775 - 75,163}{18}$ = 3,090 acre feet, or approximately $309,000, a considerable amount for an inch of error in the estimate. The plan, however, will be a long-term program, and later experience in operation may show whether too much or too little channel capacity freeboard has been provided herein for operational storage. If it is not enough or is too much there will be time to adjust the plan accordingly.

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1. Authority: Charles D. Hopkins, Jr. Ass. M. A.S.C.E., U. S. Weather Bureau, River Forecast Center.

The operational storage estimate is contingent upon the following premises:

(i) That the control of the dams is under efficient management with adequate personnel and equipment.

(ii) That surveys are made to observe the condition of the soil, the depth to the ground water table, to record the accumulation of snow during the winter, and particularly the condition of the soil and the depth and the weight of the snow pack at the spring break-up.

(iii) The rapid assembly at the control centre of rainfall and run-off information, stream gauge records at the areas subject to flooding, at the dams and any other strategic places.

(iv) A sound and rapid system of communication together with an emergency operating plan in the event of failure of the communication system. The system should be such that information from the operation personnel at gauges, dams, meteorological stations and any other places that would influence the control of the dams could be transmitted to the control centre, and that instructions issued by the control centre would be transmitted quickly and with the assurance that the information is reliable and the instructions sent out understood and carried out.

(v) That a basic plan is installed at each reservoir.

(vi) That weather forecasts are made by the best means available.

(vii) That discharge curves are prepared for the discharge tubes control, valves, gates and spillways together with curves for storage capacities and time of wave travel.

(viii) Any other measures employed that would increase the efficiency of the control centre.

(4) Boost Discharge Storage

Boost storage is a necessary increase in the head of water at the dam in order that the dam, during the first part of the spring run-off period, may be able to discharge a volume

of water equal to the inflow into the reservoir. In order that the function of the boost storage may be understood, some particulars concerning dam regulation which conform to the hypothetical hydrograph should be explained.

For the hypothetical spring flood period, and for floods approaching this magnitude, the regulation of the dams should be such that the flows through London should conform approximately to the hypothetical hydrograph; which means that the flow should follow the rising limb, until the flow reaches the stage between the operational and channel capacity rates (30,410 c.f.s. and 35,670 c.f.s. respectively); and if, during this interval of the rising limb, the discharge from the dams is equal to the inflow into the reservoirs, the flows through London will conform to the hydrograph. After the flows have reached that stage, the inflow into the reservoirs would be greater than the discharge from the dams, and the water level in the reservoirs would rise and the reservoirs would be full at the time the falling limb reached the channel capacity rate of flow. At this time the peak of the flood has passed, the surface run-off is complete except for the contribution of ground water flow, the water is all in the river and its tributaries; and, provided there is no further precipitation or added discharge from the reservoir, the stages at London would conform to the falling limb and recede to base flow.

If, during the rising interval, the discharge from the dams should be less than the inflow into the reservoirs, the reservoirs would fill prematurely, and if the run-off were of the hypothetical magnitude would result in a flood. Consequently, in order that the dams may be able to discharge the inflow, provision must be made in both the design of the discharge tubes and the head of water over them.

At the beginning of the spring break-up, any conservation storage left in the reservoirs would be dumped to the dead storage level to provide space for the approaching flood.

At the dead storage level it would not be practicable to provide discharge tubes of sufficient size and number to discharge the inflow at such a low head, hence the head must be increased or "boost discharge storage" provided to the extent that tubes may be designed economically to discharge the inflow.

The volume of boost storage required depends upon the drainage area of the reservoir, the amount of the run-off and the design of the dam, and will vary for each reservoir. The design of the dams is beyond the scope of this report, but an estimate of the boost flow storage is necessary at this time, and is 7,800 acre feet.

Table H-7 shows the reservoir distribution of this storage and it may be noted that there has been, comparatively, a greater amount allocated to Fanshawe than to the other reservoirs. This was done partly to enable the Fanshawe tubes to discharge an amount approaching channel capacity and also because of the possibility that the additional storage might be needed as a domestic supply for London, in which case it would be considered as dead storage. Actually the storage available in the six reservoirs was 1,070 acre feet greater than the determined storage, and this excess was put into the boost storage at Fanshawe, which explains why the determined storage happens to be exactly the same as the capacity of the reservoirs.

(5) Total Storage Required Above London

A summation of the foregoing storage classifications is tabulated below:

TABLE H-E

Storage	Acre Feet	Percentage of Total Storage
(1) Channel capacity storage	75,160	67.67
(2) Dead storage	2,100	1.89
(3) Operational storage	26,017	23.42
(4) Boost discharge storage	7,803	7.02
Total storage required above London	111,080	100.00

From the above, the efficiency in the operation of dual-purpose reservoirs is $\frac{75,160}{75,160 + 26,017} \times 100 = 74.28$ per cent.

5. Water Conservation Storage and Increased Flows

Excluding Fanshawe, the other five reservoirs when full have a total capacity of 64,500 acre feet. It is assumed that the reservoirs would be full at the end of the spring flood period and unless the month of May were dry they would remain full or nearly so until June 1. This is about the time when the flows in the rivers need to be increased and the impounded water in the reservoirs may then be released to sustain the flow.

All of the above potential storage is not available as conservation storage and deductions must be made for certain losses.

(a) Space for a hypothetical rainstorm.

(b) Loss by water surface evaporation and ice formation

(c) Dead storage

The above storage losses are shown in Tables H-3 and H-4 and an explanation of each follows:

(a) Space for a Hypothetical Rainfall

The hypothetical rainfall is a planned-for rain that might occur at any time after the spring freshet and for which space must be made available in the reservoirs as soon as possible after the spring run-off in the case that they have been filled to capacity or above the limiting stage. For such a rainfall the same pattern has been followed as for the spring floods, viz: a run-off volume 1-1/3 times the greatest run-off on record by rainfall only; the preparation of run-off graphs of the greatest rainfall run-off of record (for both branches at London); the construction of the hydrograph at the Forks; and from it the determination of the storage space to be made available for the hypothetical rainfall.

Although May on the average is not the wettest month, the greatest run-off on record resulting from rainfall occurred during that month. The run-off factor is not as high in May as in April, when the ground may be saturated and partly frozen, and provision must be made therefore for the hypothetical rainfall occurring in April after the spring freshet.

The possibility of heavy rain during the spring freshet has been already provided for in the hypothetical spring flood. During the summer months the water level of the reservoirs would be progressively lowered and would reach a stage when there would be no concern for the hypothetical rain. During the month of May the reservoirs would be filled to the determined level, and as it is often a wet month it is a time for caution. The critical time and one which causes concern and anxiety for the controller is the time immediately following the spring freshet. It is assumed that the snow melt will have been completed or nearly so and that the spring floods will have receded to base flow. The ground at that time would be saturated and partly frozen and with heavy rain the run-off factor would be very high. It is improbable that the hypothetical spring flood would be shortly followed by the hypothetical rainfall, but a condition is possible whereby, with a late spring and with a heavy snow blanket, the snow melt might be rapid due to a sudden rise in temperature and then the hypothetical rain might follow on the heels of the spring run-off. Space in the reservoirs is provided therefore for this contingency.

During the average spring freshet the reservoirs would not exceed the conservation level, but should they exceed the conservation level or be filled to capacity they would be dumped as soon as possible to that level and the space thus made available until about June 1. Normally June 1 is the beginning of the dry period when the impounded water is discharged to increase the low flows. At the approach of the spring freshet the reservoirs would normally be down to the dead storage level, but if not they would be lowered to that level.

For the average spring run-off period the dams can be operated so that the reservoirs will not exceed the conservation water level which will leave space at that time for the unpredictable.

The greatest volume of flow recorded for rains on the North Branch (other than rain during the spring freshet periods) occurred in May 1945 (Fig. H-17), 4.215 inches of rain having fallen over a period of five days from the 14th to the 18th, with a maximum mean daily flow of 15,280 c.f.s. at Western University gauge and a volume above base flow of 64,155 acre feet or a run-off of 43.4 per cent.

The greatest volume of flow recorded for rain only on the South Branch also occurred in May 1945, 3.27 inches of rain having fallen over a period of five days from the 14th to the 18th, with a maximum mean daily flow of 6,570 c.f.s. at Ealing gauge and a volume above base flow of 30,030 acre feet or a run-off of 33.2 per cent.

Run-off graphs were prepared for the greater rainstorms for both the North and the South Branches and from them the North Branch for $80,985 \times \frac{3}{2} = 107,980$ acre feet shows a maximum mean daily of 26,800 c.f.s., and the South Branch for $44,450 \times \frac{3}{2} = 59,267$ acre feet shows a maximum mean daily of 12,140 c.f.s.

A hydrograph for the hypothetical rainstorm was constructed at the Forks by combining the above flows on top of a base flow of 4,000 c.f.s., using the same tentative channel capacity at the Forks, viz. 31,725 c.f.s., the storage space to be held in reserve above London for a hypothetical rainstorm amounts to 7,876 acre feet. By applying the run-off ratios the distribution of the storage space would be:

Ac.Ft.		Ratio		
7,876	x	.6456	=	5,085 acre feet for the North Branch
and 7,876	x	.3544	=	2,791 acre feet for the South Branch

This storage space provides for a storm equivalent to 4.41 inches of rain over the whole watershed with a run-off factor of 60 per cent and is equivalent to 2.65 inches of run-off. Increasing this to 75 per cent, as indicated by the average run-off factor for April, the storage amounts to

$$\frac{75}{60} \times 7{,}876 = 9{,}897 \text{ acre feet}$$

TABLE H-F

Monthly percentage of run-off to precipitation based on the monthly mean records for Western and Ealing Hydrometric Stations and London, Stratford and Woodstock Meteorological Stations.

Month	March	April	May	June	July
Precipitation Depth in inches Aver. 3 sta's	2.71	2.65	2.91	3.12	3.22
Run-off Depth in inches Aver. 2 sta's	2.45	1.99	0.75	0.41	0.27
Percentage Run-off	90	75	26	13	8

The proportion of storage space reserved for rain for the

North Branch: 9,897 x .6456 = 6,390 acre feet

South Branch: 9,897 x .3544 = 3,507 acre feet

This storage space provides for a storm equivalent to 4.41 inches of rain over the watershed with a run-off factor of 75 per cent and is equivalent to 3.31 inches of run-off.

(b) Loss by Water Surface Evaporation and Ice Formation

From the first of June to the end of September the water surface evaporation exceeds precipitation by about a foot in depth. During the other months there is little or no evaporation. If, however, storage is used to increase and sustain

low flows the year round, there is also a loss due to the formation of ice on the reservoirs, which could not be discharged before the spring break-up. The thickness of ice would vary with the temperature, snow cover and the periodic breakdown and submerging of ice as the water levels were lowered. The ice loss has been estimated at one foot.

The loss by evaporation in the reservoirs for an average summer period of 112 days is approximately 2,620 acre feet and the loss, including that for ice, of sustained flows for an average year for the 273-day period is estimated at 5,120 acre feet.

(c) Loss by Dead Storage

Dead storage has already been described and accounted for in sub-section (g)(2) of section 4.

(d) Conservation Storage Available for Increased and Sustained Flows at London

The above storage losses and the remaining conservation storage which would be available for increasing low flows for each of the reservoirs are shown in Tables H-3 and H-4. The sustained flows at London for both branches for a summer period of 112 days (June 1 to September 20 inclusive) and for a yearly period of 273 days (June 1 to February 28 inclusive) are also shown.

The storage capacities for all of the reservoirs and the area flooded by each at the various water levels are shown in Figures H-24, H-25 and H-26.

A diagram illustrating the various storage classifications and the allocation of the storage space for flood control and conservation purposes is shown in Figure H-27.

TABLE H-1

THE DISTRIBUTION OF THE REQUIRED 111,080 ACRE FEET FLOOD CONTROL STORAGE ABOVE LONDON AND THE CAPACITY AND SELECTION OF RESERVOIRS

Reservoir	Capacity in Ac.Ft.		Reservoir Selection		
	Top of Spillway	Max. Holding Storage	Above London Ac.Ft.	Above St.Marys Ac.Ft.	Above Woodstock Ac.Ft.
Glengowan	(1)26,954±	25,000±	26,954±	26,954±	
Wildwood	14,900	13,900	14,900	14,900	
Fish Creek	(2)11,753				
Fanshawe	38,880	(3)	(4)38,880		
Medway	(2)21,507				
Sub-total	113,994	38,900	80,734	(5)41,854	
Woodstock	5,152	4,300	5,152		5,152
Cedar Creek	7,728	5,600	7,728		7,728
Thamesford	17,466	15,700	17,466		
Sub-total	30,346	25,600	30,346		(5)12,880
Grand Total	144,340	64,500	111,080		
Required Storage			111,080	(6)57,300	(6)18,300

Notes

(1) Storage approximate. Contour survey was not completed.

(2) Reservoirs surveyed but not included in plan.

(3) No water conservation storage available from Fanshawe.

(4) Assuming that the 10,000 acre feet for the Fanshawe Recreational Lake will be lowered to the dead storage level prior to the spring break-up. Otherwise 4,070 acre feet short.

(5) Flood control storage short and to be supplemented by some local channel improvement work.

(6) This storage is tentative as it was deduced from channel capacity tests made in 1948. Results to be checked by further tests.

S U M M A R Y   O F   M E A N   M O N T H L Y   D I S C H A R G E S

North Branch at WESTERN -- 1916 to 1950

SPRING RUN - OFF. Accretion Period - Reservoir Filled. 3 Months or 92 Days. CUBIC FEET PER SECOND						RUN-OFF for the following SUMMER, FALL and WINTER. Draft Period of Reservoirs - Flow in the River is increased and sustained. 9 Months or 273 Days. CUBIC FEET PER SECOND												YEAR. CUBIC FEET PER SECOND	
YEAR	MAR.	APRIL	MAY	TOTAL FOR PERIOD	AV'GE FOR PERIOD	YEAR	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL FOR PERIOD	AV'GE FOR PERIOD	TOTAL FOR YEAR	AV'GE FOR YEAR
1914						1914-15													
1915						1915-16													
1916	1261	2090	1074	4425	1475	1916-17	1080	147	27	23	37	70	159	391	89	2023	225	6448	537
1917	2475	1144	518	4137	1379	1917-18	551	1284	54	42	118	169	189	86	174	2667	296	6804	567
1918	2580	607	79	3266	1089	1918-19	63	26	26	81	33	75	1261	706	423	2694	299	5960	497
1919	1390	1413	1413	4216	1405	1919-20	132	30	33	30	95	414	309	69	71	1183	131	5399	450
1920	1728	835	174	2737	912	1920-21	60	159	56	49	97	569	1226	870	291	3377	375	6114	509
1921	2043	1366	357	3766	1255	1921-22	107	149	44	36	208	489	1331	423	1273	4060	451	7826	652
1922	1401	2510	170	4081	1360	1922-23	509	72	60	137	70	85	88	176	84	1281	142	5362	447
1923	2697	1856	1226	5779	1929	1923-24	455	72	44	149	61	190	1600	1097	382	4050	450	9829	819
1924	2300	1693	1156	5149	1716	1924-25	152	93	105	51	47	47	110	20	1097	1722	191	6871	573
1925	2090	284	81	2455	818	1925-26	44	32	30	34	50	70	451	286	262	1259	140	3714	309
1926	2569	2814	267	5650	1883	1926-27	114	30	372	550	852	2335	420	237	823	5733	637	11383	949
1927	2393	309	671	3373	1124	1927-28	184	881	90	51	61	439	1144	835	677	4362	485	7735	645
1928	2347	1051	168	3566	1189	1928-29	365	334	230	64	411	1471	1448	1109	259	5691	632	9257	771
1929	3923	1961	975	6859	2286	1929-30	110	71	44	37	46	77	62	1681	3222	5350	594	12209	1017
1930	1016	1203	299	2518	839	1930-31	223	76	32	53	49	35	113	41	69	691	77	3209	267
1931	1390	1530	354	3274	1091	1931-32	92	336	239	76	83	595	1027	1856	1103	5407	601	8681	723
1932	899	1138	536	2573	858	1932-33	148	124	111	194	246	1080	1284	666	549	4402	489	6975	581
1933	1045	1891	386	3322	1107	1933-34	105	55	54	50	56	227	465	870	260	2142	238	5364	447
1934	1459	2265	92	3816	1272	1934-35	51	48	39	46	—	—	—	—	—	—	—	—	—
1935	—	—	—	—	—	1935-36	—	—	—	—	48	584	362	188	231	—	—	—	—
1936	2884	1180	439	4503	1501	1936-37	270	19	12	25	60	139	776	1961	1238	4500	500	9003	750
1937	389	3409	543	4341	1447	1937-38	209	65	57	67	—	—	—	203	3351	—	—	—	—
1938	2137	539	244	2920	973	1938-39	100	35	47	33	30	35	47	184	654	1165	129	4085	340
1939	2008	2183	125	4316	1439	1939-40	70	48	46	35	56	111	75	75	104	620	69	4936	411
1940	203	4156	870	5229	1743	1940-41	491	186	195	381	439	940	1950	654	321	5557	617	10786	899
1941	811	1424	110	2345	783	1941-42	82	33	22	47	196	590	459	502	364	2295	255	4640	387
1942	2965	677	403	4045	1348	1942-43	381	62	32	590	718	1926	823	546	1903	6981	776	11026	919
1943	3351	1319	1529	6199	2066	1943-44	411	246	165	165	38	118	168	366	565	2242	249	8441	703
1944	1600	1670	472	3742	1247	1944-45	112	31	21	89	1640	655	494	54	105	3201	356	6943	579
1945	3450	1230	1940	6620	2207	1945-46	730	780	92	293	81	384	287	1440	965	5052	561	11672	973
1946	2670	248	269	3187	1062	1946-47	228	76	69	55	64	70	320	1610	590	3082	342	6269	522
1947	1970	4500	1060	7530	2510	1947-48	1910	408	110	199	68	99	780	270	894	4738	526	12268	1022
1948	4100	922	937	5959	1986	1948-49	99	63	45	16	41	208	198	1400	2280	4350	483	10309	859
1949	1670	507	111	2288	763	1949-50	31	35	16	26	83	82	—	2310	644	—	—	—	—
1950	2680	2310	173	5163	1721	1950-51	60	78	105	41	75	788	1574	1860	1678	6259	695	11422	952
1951						1951-52													
1952						1952-53													
Min. Year 1930	1016	1203	299	2518	839	Min. Year 1930-31	223	76	32	53	49	35	113	41	69	691	77	3209	267
Max. Year 1947	1970	4500	1060	7530	2510	Max. Year 1947-48	1910	408	110	199	68	99	780	270	894	4738	526	12268	1022
Av'ge Year	2055	1640	565	4260	1420	Av'ge Year	280	181	98	117	195	469	667	803	764	3574	397	7834	653

S U M M A R Y   O F   M E A N   M O N T H L Y   D I S C H A R G E S

South Branch at EALING -- 1915 to 1950

SPRING RUN - OFF. Accretion Period - Reservoir Filled. 3 Months or 92 Days. CUBIC FEET PER SECOND						RUN-OFF for the following SUMMER, FALL and WINTER. Draft Period of Reservoirs - Flow in the River is increased and sustained. 9 Months or 273 Days. CUBIC FEET PER SECOND												YEAR. CUBIC FEET PER SECOND	
YEAR	MAR.	APRIL	MAY	TOTAL FOR PERIOD	AV'GE FOR PERIOD	YEAR	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	TOTAL FOR PERIOD	AV'GE FOR PERIOD	TOTAL FOR YEAR	AV'GE FOR YEAR
1914						1914-15													
1915						1915-16	180	200	578	433	414	468	565	2140	719	5697	633		
1916	1200	1230	1210	3640	1213	1916-17	935	145	124	72	115	111	159	250	116	2027	225	5667	472
1917	1480	1080	705	3265	1088	1917-18	990	1200	166	115	270	289	209	116	995	4350	483	7615	635
1918	2070	453	246	2769	923	1918-19	115	37	26	161	128	174	585	535	318	2079	231	4848	404
1919	1200	900	1080	3180	1060	1919-20	159	67	63	77	166	314	260	87	93	1286	143	4466	372
1920	1560	660	228	2448	816	1920-21	113	165	138	71	136	348	625	570	240	2406	267	4854	404
1921	1280	1050	346	2676	892	1921-22	146	550	115	121	274	449	920	457	940	3972	441	6648	554
1922	865	1640	236	2741	914	1922-23	442	146	134	213	125	145	138	233	89	1665	185	4406	367
1923	1670	1060	487	3217	1072	1923-24	195	110	69	141	79	145	1200	880	342	3161	351	6378	531
1924	1660	1120	915	3695	1232	1924-25	258	154	213	105	112	99	148	99	1360	2548	283	6243	520
1925	1800	348	131	2279	760	1925-26	61	57	75	74	89	343	247	246	268	1460	162	3739	312
1926	2010	1810	292	4112	1371	1926-27	153	62	228	540	750	1690	396	232	665	4716	524	8828	736
1927	1610	494	635	2739	913	1927-28	218	575	123	86	118	437	950	705	575	3787	421	6526	544
1928	1010	860	241	2111	704	1928-29	545	243	173	96	253	720	730	850	245	3855	428	5966	497
1929	2220	1570	750	4540	1513	1929-30	161	105	79	67	80	174	93	1620	2130	4509	501	9049	754
1930	1020	750	239	2009	670	1930-31	183	71	55	63	64	67	94	69	113	779	87	2788	232
1931	695	615	239	1549	516	1931-32	106	182	100	107	94	197	555	1630	890	3861	429	5410	451
1932	610	780	670	2060	687	1932-33	299	199	165	184	191	675	855	600	520	3688	410	5748	479
1933	955	1380	234	2569	856	1933-34	90	78	77	67	74	157	281	750	341	1915	213	4484	374
1934	1240	1690	208	3138	1046	1934-35	84	83	86	130	94	146	121	725	530	1999	222	5137	428
1935	1630	222	250	2102	701	1935-36	163	69	66	56	62	170	183	126	260	1155	128	3257	271
1936	1910	750	256	2916	972	1936-37	64	22	26	32	40	90	202	1960	1380	3816	424	6732	561
1937	409	2710	565	3684	1228	1937-38	285	86	124	102	205	174	135	195	2490	3796	422	7480	623
1938	1260	540	273	2073	691	1938-39	132	55	103	74	58	75	89	185	835	1606	178	3679	307
1939	1330	1690	196	3216	1072	1939-40	89	68	76	57	66	67	68	72	73	636	71	3852	321
1940	203	2020	530	2753	918	1940-41	525	195	172	382	237	545	1300	520	248	4124	458	6877	573
1941	540	570	102	1212	404	1941-42	61	52	68	64	69	138	137	195	411	1195	133	2407	201
1942	1490	448	311	2249	750	1942-43	238	113	94	267	482	1010	735	750	1640	5329	592	7578	631
1943	1960	825	1270	4055	1352	1943-44	580	456	137	101	99	152	149	194	355	2223	247	6278	523
1944	935	895	354	2184	728	1944-45	169	82	75	139	93	88	100	49	130	925	103	3109	259
1945	1470	955	1160	3585	1195	1945-46	496	323	164	216	925	390	308	720	675	4217	469	7802	650
1946	1530	203	228	1961	654	1946-47	207	102	104	104	132	157	332	1050	430	2618	291	4579	382
1947	1360	2460	940	4760	1587	1947-48	1040	232	157	200	172	194	355	216	683	3249	361	8009	667
1948	1990	721	777	3488	1163	1948-49	184	303	152	103	116	243	233	787	1700	3821	425	7309	609
1949	1020	487	204	1711	570	1949-50	114	147	109	121	149	116	1145	1748	686	4335	482	6046	504
1950	1860	1541	226	3627	1209	1950-51	141	207	222	168	190	450	1015	1024	1468	4885	543	8512	709
1951						1951-52													
1952						1952-53													
Min Year 1941	540	570	103	1212	404	Min. Year 1941-42	61	52	68	64	69	138	137	195	411	1195	133	2407	201
Max. Year 1929	2220	1570	750	4540	1513	Max. Year 1929-30	161	105	79	67	80	174	93	1620	2130	4509	501	9049	754
Av'ge Year	1344	1043	478	2865	955	Av'ge Year	276	193	129	142	187	311	434	627	693	2992	332	5857	488

TABLE H-2

TABLE H - 3

NORTH BRANCH - THAMES RIVER

Losses in Reservoir Space Due to
Evaporation and Winter Ice
Dead Storage
and Reserved Space for a Hypothetical Rain Storm
and
WATER CONSERVATION AND SUSTAINED FLOWS
AVAILABLE AT LONDON

For a Summer Flow Period from June 1 to Sept. 20 - 112 days
and a Yearly Flow Period from June 1 to March 1 - 273 days

or the Driest Year since 1915 viz. the Summer of 1939 & Winter of 1940
nd for the Average Period since 1915.

eservoir	Mean Surface Area Acres	Losses in Reservoir Space Acre Feet				Holding Capacity Acre Feet	Water Conservation Storage Acre Feet	Average Discharge From Reservoirs C.F.S.	Average Run-off above London C.F.S.	Average Sustained Flow at London C.F.S.
		By Evaporation and Winter Ice	By Dead Storage Approximately	Space Reserved For Hypothetical Rain Storm	Total Loss in Reservoir Space					
For the Driest Year - Summer Flow - 112 Days										
lengowan	600	670	300	3250	4220	25000	20780	93.5		
ildwood	430	480	200	620	1300	13900	12600	56.7		
nshawe	710	790	800	2510	4100					
otal	1740	1940	1300	6380	9620		33380	150.2	51.1	201.3
For the Driest Year - Yearly Flow - 273 Days										
lengowan	600	1180	300	3250	4730	25000	20270	37.4		
ildwood	430	850	200	620	1670	13900	12230	22.6		
nshawe	710	1400	800	2510	4710					
otal	1740	3430	1300	6380	11110		32500	60.0	68.4	128.4
For the Average Year - Summer Flow - 112 Days										
lengowan	600	390	300	3250	3940	25000	21060	94.8		
ildwood	430	280	200	620	1100	13900	12800	57.6		
nshawe	710	460	800	2510	3770					
otal	1740	1130	1300	6380	8810		33860	152.4	173.1	325.5
For the Average Year - Yearly Flow - 273 Days										
lengowan	600	760	300	3250	4310	25000	20690	38.2		
ldwood	430	550	200	620	1370	13900	12530	23.1		
nshawe	710	900	800	2510	4210					
otal	1740	2210	1300	6380	9890		33220	61.3	394.3	455.6

te: Space reserved for hypothetical rain storm is based on 4.41 in. with a run-off factor of 75 per cent prior to May 10.

TABLE H - 4

SOUTH BRANCH - THAMES RIVER

Losses in Reservoir Space Due to
Evaporation and Winter Ice
Dead Storage
and Reserved Space for a Hypothetical Rain Storm
and
WATER CONSERVATION AND SUSTAINED FLOWS
AVAILABLE AT LONDON

For a Summer Flow Period from June 1 to Sept. 20 - 112 Days
and a Yearly Flow Period from June 1 to March 1 - 273 Days

or the Driest Period Since 1915 viz. The Summer of 1939 & Winter of 1940
nd for the Average Period since 1915.

Reservoir	Mean Surface Area Acres	Losses in Reservoir Space Acre Feet				Holding Capacity Acre Feet	Water Conservation Storage Acre Feet	Average Discharge from Reservoirs C.F.S.	Average Run-off above London C.F.S.	Average Sustained Flow At London C.F.S.
		By Evaporation and Winter Ice	By Dead Storage Approximately	Space Reserved for Hypothetical Rain Storm	Total Loss in Reservoir Space					
For the Driest Year - Summer Flow - 112 Days										
oodstock	350	400	200	1420	2020	4300	2280	10.3		
edar Creek	700	800	200	460	1460	5600	4140	18.6		
hamesford	550	630	400	1630	2660	15700	13040	58.7		
otal	1600	1830	800	3510	6140	25600	19460	87.6	73.9	161.5
For the Driest Year - Yearly Flow - 273 Days										
Woodstock	350	640	200	1420	2260	4300	2040	3.8		
Cedar Creek	700	1270	200	460	1930	5600	3670	6.7		
Thamesford	550	1000	400	1630	3030	15700	12670	23.3		
Total	1600	2910	800	3510	7220	25600	18380	33.8	70.4	104.2
For the Average Year - Summer Flow - 112 Days										
oodstock	350	330	200	1420	1950	4300	2350	10.6		
edar Creek	700	650	200	460	1310	5600	4290	19.3		
hamesford	550	510	400	1630	2540	15700	13160	59.2		
otal	1600	1490	800	3510	5800	25600	19800	89.1	188.4	277.5
For the Average Year - Yearly Flow - 273 Days										
oodstock	350	640	200	1420	2260	4300	2040	3.8		
edar Creek	700	1270	200	460	1930	5600	3670	6.7		
hamesford	550	1000	400	1630	3030	15700	12670	23.4		
otal	1600	2910	800	3510	7220	25600	18380	33.9	329.5	363.4

ote: Space reserved for hypothetical rain storm is based on 4.41 in. with a run-off factor of 75 per cent prior to May 10.

DAM AND RESERVOIR DATA FOR PROPOSED FLOOD CONTROL SCHEME

Reservoir	Length of Dam	Discharge Capacity not less than:	Elevation G.S.C.			Height above Stream Bed	Depth to Bed Rock	Height above Bed Rock	Storage	Cost	
			Bed of Stream	Top of Spill-way	Top of Dam					Total	Unit
	Feet	C.F.S.	Feet	Feet	Feet	Feet	Feet	Feet	Ac. Ft.	$	$/Ac.Ft.
Glengowan	1,200	45,000	1,007.0	1,065	1,071	64.0	4.0	68.0	26,954	2,020,000	75.00
Wildwood	1,790	12,000	1,018.0	1,065	1,071	53.0	4.0	57.0	14,900	1,407,000	94.50
Fish Creek ☆	980	7,000	940.0	975	981	41.0	-	-	11,753	-	-
Fanshawe	2,050	87,000	819.0	890	896	77.0	23.0	100.0	38,880	4,711,250	121.17
Medway ☆	950	14,000	810.0	880	886	76.0	-	-	21,507	-	-
North Branch Sub-Total									80,734	8,138,250	100.80
Woodstock	1,440	10,000	915.0	940	946	31.0	ø 10.0	41.0	5,152	760,000	147.50
Cedar Creek	1,100	6,000	928.5	950	956	27.5	ø 10.0	37.5	7,728	604,000	78.20
Thamesford	1,200	19,000	916.5	960	966	49.5	ø 25.0	74.5	17,466	2,440,000	139.70
South Branch Sub-Total									30,346	3,804,000	125.68
Total									111,080	11,942,250	107.51

☆ Surveyed, but not included in scheme

ø Estimated

TABLE H-6

SUNDRY DRAINAGE AREAS & PERIODS OF GAUGE RECORDS

Tributaries		Places		Damsites		Hydrometric Gauges				
Name	Drainage Area Square Miles	Name	Drainage Area Square Miles	Name	Drainage Area Square Miles	Name	Drainage Area Square Miles	Period of Records		
								From	To	Years
North Branch		London at Forks	661.4	Fanshawe	560.2	Fanshawe	562.9	1915	1944	30
Medway R.	74.7	London	657.0	Medway	72.3	Western Univ.	657.2	1944	1950	7
Avon R.	59.1	Stratford	29.2			Medway	69.8	1946	1950	5
Trout Creek	64.8	St. Mary's Trout Cr.	64.0	Wildwood	54.6	Trout Creek	54.6	1946	1950	5
Fish Creek	58.7	St. Mary's North Br.	351.0	Fish Creek	56.3	Fish Creek	57.7	1946	1950	5
Whirl Creek	55.0	Mitchell	119.0	Glengowan	285.2	St. Mary's	416.0	1938	1950	13
Flat Creek	33.9									
South Branch		London at Forks	529.2	Woodstock	97.6	Ealing	519.1	1915	1950	36
Waubuno Cr.	39.3	London	517.6	Cedar Creek	31.4	Ingersoll	214.4	1938	1950	13
Cedar Creek	37.6	Woodstock	141.8							
Reynolds Cr.	58.7	Ingersoll	219.9							
Middle Branch	132.8	Thamesford	117.6	Thamesford (Upper)	112.0	Thamesford	117.6	1938	1950	13
				Thamesford (Lower)	112.2					
Total for Tributaries above London			1190.6			Kilworth	1250.0	1914	1922	9
Thames River - Upper Thames Watershed			1324.9			Byron	1203.4	1923	1931	9
								1938	1950	13

Note: For Gauge Locations See Fig. H-5

APPROXIMATE SPACE ALLOWANCE IN RESERVOIRS FOR DEAD AND BOOST FLOW STORAGE

And the space to be made available as soon as possible after every spring flood and reserved until May 10 for a hypothetical rainstorm of 4.41 inches over the whole Upper Thames Watershed, with a 75 per cent run-off factor which might occur during that period, and the space after May 10 for a similar storm with a 45 per cent run-off factor should rain after that date make it possible to reduce the space and increase the conservation storage.

Reservoir	Capacity Top of Spillway	Dead Storage	Boost Flow Storage	Total Dead & Boost Flow Storage	Depth of Water at Dam		Elevation Top of Spillway	Minimum Reserved Space until May 10 Made Available by Dumping after Every Spring Flood			Minimum Reserved Space after May 10 Should Rain Raise the Water Level in Reservoirs		
					For Dead Storage Only	For Both Dead & Boost Storage		Space	Depth below Spillway to Water Level:	Elevation of Water Level	Space	Depth below Spillway to Water Level:	Elevation of Water Level
	Ac.Ft.	Ac.Ft.	Ac.Ft.	Ac.Ft.	Ft.	Ft.	Ft.	Ac.Ft.	Ft.	Ft.	Ac.Ft.	Ft.	Ft.
Glengowan	26,954	300	1,600	1,900	13.0	21.0	1,065.0	3,250	2.5	1,062.5	1,952	1.5	1,063.5
Wildwood	14,900	200	900	1,100	10.0	17.5	1,065.0	620	0.9	1,064.1	374	0.5	1,064.5
Fanshawe	38,880	800	3,403	4,200	17.5	30.2	890.0	2,510	1.8	888.2	1,508	1.1	888.9
Woodstock	5,152	200	300	500	9.9	12.5	940.0	1,420	2.6	937.4	853	1.5	938.5
Cedar Creek	7,728	200	500	700	9.9	12.8	950.0	460	0.3	949.7	275	0.2	949.8
Thamesford	17,466	400	1,100	1,500	13.2	20.7	960.0	1,630	1.5	958.5	980	1.0	959.0
Total	111,080	2,100	7,803	9,900				9,890			5,942		

MONTHLY MAXIMUM, MINIMUM AND MEAN DISCHARGES

SOUTH BRANCH AT EALING DRAINAGE AREA = 519.1 SQUARE MILES

YEAR	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915																287	68	180	565	60	200	1420	234	578	1530	162	433	705	198	414	1200	163	468	955	375	565
1916	6540	520	2140	4540	470	719	6330	470	1200	2890	520	1230	3120	455	1210	3170	280	935	246	72	145	105	55	124	148	50	72	267	64	115	227	38	111	239	104	159
1917	605	155	250	380	38	116	4770	352	1480	3460	396	1080	2450	215	705	3560	307	990	4560	215	1200	321	116	166	191	60	115	780	60	270	510	176	289	404	104	209
1918	176	55	116	6800	19	995	5130	580	2070	1030	221	453	780	101	246	306	28	115	101	7	37	60	2	26	359	28	161	278	74	128	227	132	174	1850	162	585
1919	2940	167	535	1350	88	318	5200	314	1200	2720	300	900	3220	308	1080	320	66	159	100	40	67	90	32	63	239	32	77	600	68	166	1410	173	314	925	110	260
1920	110	75	87	95	85	93	7810	100	1560	1410	382	660	515	110	228	178	63	113	675	80	165	500	48	138	100	48	71	403	52	136	745	188	348	1620	330	625
1921	2160	209	570	570	120	240	3280	200	1280	5360	329	1050	1060	160	346	269	97	146	6220	67	550	368	67	115	200	85	121	970	80	274	1520	117	449	6340	220	920
1922	2780	150	457	5510	150	940	2080	340	865	5830	322	1640	402	125	236	2400	105	442	297	83	146	325	70	134	565	58	213	208	75	125	169	112	145	301	92	138
1923	840	139	233	138	70	89	4000	105	1670	4590	280	1060	2480	178	487	448	95	195	343	51	110	133	37	69	440	62	141	103	59	79	382	91	145	3540	422	1200
1924			880			342	4720		1660	2870	382	1120	3500	282	915	426	138	258	263	76	154	700	61	213	207	58	105	214	71	112	147	67	99	266		148
1925			99	7260		1360	7630	540	1800	690	182	348	200	84	131	91	45	61	84	45	57	135	45	75	116	42	74	144	55	89	770	104	343	805		247
1926			246			268	9230		2010	6770	580	1810	805	135	292	510	93	153	109	40	62	790	58	228	2960	91	540	1610	298	750	4060	705	1690			396
1927			232			665	3630	362	1610	1120	302	494	1690	186	635	422	107	218	4270	74	575	318	80	123	114	64	86	215	86	118	3510	95	437			950
1928			705			575	4060		1010	2470	297	860	580	127	241	2260	109	545	760	120	243	685	86	173	120	80	96	635	86	253	2640	252	720			730
1929			850			245			2220	5520	455	1570	2420	262	750	375	90	161	132	90	105	90	60	79	77	53	67	157	60	80	395	90	174			93
1930			1620			2130			1020	2540	230	750	477	120	239	710	90	183	116	50	71	65	50	55	91	50	63	73	54	64	82	54	67			94
1931			69			113	3800		695	1370	146	615	560	101	239	317	57	106	720	57	182	122	82	100	243	73	107	107	88	94	545	91	197			555
1932			1630			890			610	1550	203	780	2450	188	670	1070	97	299	367	97	199	310	79	165	570	82	184	379	111	191	1220	202	675			855
1933			600			520	3630	317	955	3750	282	1380	355	111	234	134	62	90	118	57	78	107	57	77	88	57	67	111	57	74	367	55	157			281
1934			750			341			1240	4260	407	1690	435	134	208	134	62	84	122	50	83	101	73	86	218	82	130	124	54	94	212	89	146			121
1935			725			530	7390	468	1630	427	102	222	455	77	250			163			69			66			56			62	347	31	170			183
1936			126			260	5340	825	1910	1530	315	750	725	45	256	247	10	64	51	10	22	45	15	26	45	10	32	75	18	40	335	25	90			202
1937			1960			1380	1640	162	409	22160	307	2710	1830	285	565	550	102	285	190	41	86	365	36	124	297	43	102	845	43	205	285	102	174			135
1938			195	10930	285	2490	3000	365	1260	1450	215	540	515	180	273	295	48	132	91	41	55	278	56	103	107	53	74	84	45	58	135	41	75	165	35	89
1939			185			835	4060	320	1330	5150	425	1690	337	122	196	150	62	89	93	56	68	109	60	76	77	49	57	122	45	66	87	49	67	87	51	68
1940			72			73			203	8100	268	2020	1560	212	530	2070	185	525	535	75	195	1780	57	172	1000	207	382	545	154	237	1500	207	545			1300
1941			520			248	875	199	540	1260	151	570	138	68	102	92	35	61	78	29	52	103	46	68	99	38	64	92	35	69	240	92	138	370	80	137
1942			195			411	6280		1490	975	114	448	835	110	311	670	82	238	234	68	113	151	63	94	1470	46	267	1320	126	482	2670	412	1010			735
1943			750	5930	545	1640	9700	342	1960	1750	447	825	5760	482	1270	1960	82	580	2670	133	456	272	99	137	151	72	101	180	54	99	204	110	152	165	138	149
1944			194			355	2470	195	935	2590	360	895	695	99	354	458	92	169	110	72	82	92	54	75	377	72	139	151	54	93	110	54	88	133		100
1945			49			130	3850	377	1470	3830	272	955	6570	360	1160	1090	195	496	1180	151	323	219	138	164	675	114	216	5380	325	925	685	308	390	705	151	308
1946	2610	255	720	2000	325	675	5690	290	1530	290	126	203	715	103	228	493	92	207	126	72	102	126	81	104	151	63	104	360	63	132	219	114	157	1210	114	332
1947			1050			430	7250	204	1360	13450	570	2460	2940	395	940	5960	195	1040	465	165	232	290	114	157	447	126	200	231	138	172	225	165	194	835	210	355
1948	255	180	216	3040	225	683	8630	342	1990	1680	395	721	3420	195	777	342	138	184	588	146	303	308	103	152	114	92	103	146	92	116	528	92	243	622	138	233
1949	2450	378	787	8310	290	1700	4800	290	1020	1070	325	487	325	138	204	138	92	114	273	92	147	151	92	109	151	92	121	377	92	149	165	92	116	7175	165	1145
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	412	165	226	180	107	141	545	119	207	695	121	222	249	121	168	475	121	190	1488	152	450	4860	255	1015

Note: Flows recorded at Kilworth Gauge 1915 - 1922
converted to Byron Gauge.

TABLE H-8

MONTHLY MAXIMUM, MINIMUM AND MEAN DISCHARGES

SOUTH BRANCH AT EALING DRAINAGE AREA = 519.1 SQUARE MILES

YEAR	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915																287	68	180
1916	6540	520	2140	4540	470	719	6330	470	1200	2890	520	1230	3120	455	1210	3170	280	935
1917	605	155	250	380	38	116	4770	352	1480	3460	396	1080	2450	215	705	3560	307	990
1918	176	55	116	6800	19	995	5130	580	2070	1030	221	453	780	101	246	306	28	115
1919	2940	167	535	1350	88	118	5200	314	1200	2720	300	900	3220	308	1080	320	66	159
1920	110	75	87	95	85	93	7810	100	1560	1410	382	660	515	110	228	178	63	113
1921	2160	209	570	570	120	240	3280	200	1280	5360	329	1050	1060	160	346	269	97	146
1922	2780	150	457	5510	150	940	2080	340	865	5830	322	1640	402	125	236	2400	105	442
1923	840	139	233	138	70	89	4000	105	1670	4590	280	1060	2480	178	487	448	95	195
1924			880			342	4720		1660	2870	382	1120	3500	282	915	426	138	258
1925			99	7260		1360	7630	540	1800	690	182	348	200	84	131	91	45	61
1926			246			268	9230		2010	6770	580	1810	805	135	292	510	93	153
1927			232			665	3630	362	1610	1120	302	494	1690	186	635	422	107	218
1928			705			575	4060		1010	2470	297	860	580	127	241	2260	109	545
1929			850			245			2220	5520	455	1570	2420	262	750	375	90	161
1930			1620			2130			1020	2540	230	750	477	120	239	710	90	183
1931			69			111	3800		695	1370	146	615	560	101	239	317	57	106
1932			1630			890			610	1550	203	780	2450	188	670	1070	97	299
1933			600			520	3630	317	955	3750	282	1180	355	111	234	134	62	90
1934			750			341			1240	2260	407	1690	435	134	208	134	62	84
1935			725			530	7390	468	1630	427	102	222	455	77	250			163
1936			126			260	5340	825	1910	1530	315	750	725	45	256	247	10	64
1937			1960			1180	1640	162	409	22160	307	2710	1830	285	565	550	102	285
1938			195	10930	285	2490	3000	365	1260	1450	215	540	515	180	273	295	48	132
1939			185			835	4060	320	1330	5150	425	1690	337	122	196	150	62	89
1940			72			73			203	8100	268	2020	1560	212	530	2070	185	525
1941			520			248	875	199	540	1260	151	570	138	68	102	92	35	61
1942			195			411	6280		1490	975	114	448	835	110	311	670	82	238
1943			750	5930	545	1640	9700	342	1960	1750	447	825	5760	482	1270	1960	82	580
1944			194			355	2470	195	935	2590	360	895	695	99	354	458	92	169
1945			49			110	3850	377	1470	3830	272	955	6570	360	1160	1090	195	496
1946	2610	255	720	2000	325	675	5690	290	1530	290	126	203	715	103	228	493	92	207
1947			1050			430	7250	204	1360	13450	570	2460	2940	395	940	5960	195	1040
1948	255	180	216	3040	225	683	8630	342	1990	1680	395	721	3420	195	777	342	138	184
1949	2450	378	787	8310	290	1700	4800	290	1020	1070	325	487	325	138	204	138	92	114
1950	7625	417	1748	1512	107	686	6890	395	1860	10036	395	1541	412	165	226	180	107	141
MEAN			615			671			1345			1042			478			276

YEAR	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915	565	60	200	1420	234	578	1530	162	433	705	198	414	1200	163	468	955	375	565
1916	246	72	145	105	55	124	148	50	72	267	64	115	227	38	111	239	104	159
1917	4560	215	1200	321	116	166	191	60	115	780	60	270	510	176	289	404	104	209
1918	101	7	37	60	2	26	359	28	161	278	74	128	227	132	174	1850	162	585
1919	100	40	67	90	32	63	239	32	77	600	68	166	1410	173	314	925	110	260
1920	675	80	165	500	48	138	100	48	71	403	52	136	745	188	348	1620	330	625
1921	6220	67	550	368	67	115	200	85	121	970	80	274	1520	117	449	6340	220	920
1922	297	83	146	325	70	134	565	58	213	208	75	125	169	112	145	301	92	138
1923	343	51	110	133	37	69	440	62	141	103	59	79	382	91	145	3540	422	1200
1924	263	76	154	700	61	213	207	58	105	214	71	112	147	67	99	266		148
1925	84	45	57	135	45	75	116	42	74	144	55	89	770	104	343	805		247
1926	109	40	62	790	58	228	2960	91	540	1610	298	750	4060	705	1690			396
1927	4270	74	575	318	80	123	114	64	86	215	86	118	3510	95	437			950
1928	760	120	243	685	86	173	120	80	96	635	86	253	2640	252	720			730
1929	132	90	105	90	60	79	77	53	67	157	60	80	395	90	174			93
1930	116	50	71	65	50	55	91	50	63	73	54	64	82	54	67			94
1931	720	57	182	122	82	100	243	73	107	107	88	94	545	91	197			555
1932	367	97	199	310	79	165	570	82	184	379	111	191	1220	202	675			855
1933	118	57	78	107	57	77	88	57	67	111	57	74	367	55	157			281
1934	122	50	83	101	73	86	218	82	130	124	54	94	212	89	146			121
1935			69			66			56			62	347	31	170			183
1936	51	10	22	45	15	26	45	10	32	75	18	40	335	25	90			202
1937	190	41	86	365	36	124	297	43	102	845	43	205	285	102	174			135
1938	91	41	55	278	56	103	107	53	74	84	45	58	135	41	75	165	35	89
1939	93	56	68	109	60	76	77	49	57	122	45	66	87	49	67	87	51	68
1940	535	75	195	1780	57	172	1000	207	382	545	154	237	1500	207	545			1300
1941	78	29	52	103	46	68	99	38	64	92	35	69	240	92	138	370	80	137
1942	234	68	113	151	63	94	1470	46	267	1320	126	482	2670	412	1010			735
1943	2670	133	456	272	99	137	151	72	101	180	54	99	204	110	152	165	138	149
1944	110	72	82	92	54	75	377	72	139	151	54	93	110	54	88	133		100
1945	1180	151	323	219	138	164	675	114	216	5380	325	925	685	308	390	705	151	308
1946	126	72	102	126	81	104	151	63	104	360	63	132	219	114	157	1210	114	332
1947	465	165	232	290	114	157	447	126	200	231	138	172	225	165	194	835	210	355
1948	588	146	303	308	103	152	114	92	103	146	92	116	528	92	243	622	138	233
1949	273	92	147	151	92	109	151	92	121	377	92	149	165	92	116	7175	165	1145
1950	545	119	207	695	121	222	249	121	168	475	121	190	1488	152	450	4860	255	1015
MEAN			193			129			142			187			312			434

MONTHLY MAXIMUM, MINIMUM AND MEAN DISCHARGES

NORTH BRANCH AT WESTERN UNIV. DRAINAGE AREA = 657.2 SQUARE MILES

YEAR	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915																323	41	[illegible]
1916	12656	1284	4133	1097	467	630	7320	285	1261	4670	706	2090	2744	385	1074	3853	420	1080
1917	1413	56	391	158	51	89	13824	106	2475	3853	307	1144	1553	143	518	1868	161	551
1918	154	39	86	479	37	174	8792	307	2580	2499	85	607	326	30	79	306	26	43
1919	3900	222	706	1786	117	423	3514	514	1390	5581	303	1413	6865	318	1413	258	39	132
1920	89	61	69	71	68	71	7005	71	1728	3269	302	835	550	54	174	95	44	60
1921	4028	243	870	334	238	291	6223	406	2043	8091	358	1366	1331	132	357	230	49	107
1922	3853	100	423	1100	114	[illegible]	4367	418	1401	8465	[illegible]	2510	286	64	170	3794	42	509
1923	590	102	176	102	75	84	7425	114	2647	7507	351	1856	8628	134	1226	2569	65	455
1924			1097			382	7460		2300	6491	314	1693	4495	269	1156	320	90	152
1925			20	6445		1097	12901	285	2090	730	109	284	113	50	81	77	25	44
1926			286			262	10706		2569	13882	736	2814	946	62	267	683	47	114
1927			237			823	8523	259	2393	759	183	309	2931	88	671	544	72	184
1928			835			677	14606		2347	3164	274	1051	363	83	168	2965	60	345
1929			1109			259			3923	11267	343	1961	4226	231	975	208	68	110
1930			1681			3222			1016	5067	290	1203	718	134	299	881	70	223
1931			41			69	10788		1390	6036	219	1530	1027	107	354	188	54	92
1932			1856			1103			899	2627	183	1138	2487	109	536	420	67	148
1933			666			549	3304	258	1045	8733	236	1891	1693	142	386	170	68	105
1934			870			260			1459	12784	318	2265	230	54	92	82	42	51
1935																		
1936			188			231	7262	1039	2884	3036	402	1180	3187	65	439	2662	27	270
1937			1961			1238	1413	146	389	24016	420	3409	1681	237	543	557	100	209
1938			203	15446	613	3351	10881	642	2137	1518	196	539	724	110	244	236	40	100
1939			184			654	9399	410	2008	11593	319	2183	301	44	125	118	39	70
1940		33	75			104			203	18902	325	4156	5697	236	870	1728	134	491
1941			654			321			811	4600	231	1424	203	55	110	423	30	82
1942			502			364	15890		2965	1775	121	677	2592	76	403	2148	76	381
1943			546			1903	13076	368	3351	5184	370	1319	13345	321	1529	1670	139	411
1944			366			565	4010		1600	6260	470	1670	1010	173	472	470	33	112
1945			54			105	9340	441	3450	4720	260	1230	15280	470	1940	2750	173	730
1946			1440			965	18880	260	2670			248			269			228
1947			1610			590	13480		1970	26980	790	4500	3420	318	1060	12400	118	1910
1948			270			894	22700	413	4100	3710	413	922	3940	154	937	173	51	99
1949	6910	530	1400	10300	720	2280	12800	359	1670	1620	294	507	308	51	111	51	20	31
1950	10420	413	2310	1475	344	644	17152	359	2680	21040	470	2310	470	74	173	102	31	60
MEAN			803			764			2055			1640			565			280

YEAR	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915	1185	29	155	2604	158	718	1454	106	284	633	158	363	2977	93	790	1588	444	1009
1916	481	33	147	43	19	27	35	16	23	68	17	37	326	21	70	326	28	159
1917	1576	97	1284	102	30	54	97	18	42	525	34	118	326	26	169	404	118	189
1918	29	25	26	29	23	26	306	40	81	42	27	33	287	34	75	8041	57	1261
1919	69	13	30	76	15	33	114	2	30	397	40	95	4156	155	414	1284	98	309
1920	946	54	154	138	35	56	76	30	40	210	40	97	1786	147	569	4565	473	1226
1921	841	33	149	68	29	44	49	13	30	677	55	208	2067	82	489	10391	194	1331
1922	191	32	72	403	19	60	660	14	137	118	29	70	144	48	85	151	65	88
1923	444	19	72	91	21	44	1086	37	149	116	36	61	505	100	190	4939	581	1600
1924	393	44	93	532	34	105	104	22	51	89	33	47	91	25	47			110
1925	47	16	32	49	15	30	70	11	34	134	26	50	3678	68	70	3526		451
1926	50	21	30	3433	37	372	3141	70	550	3853	183	852	11944		2335			420
1927	9282	43	881	341	37	90	83	33	51	102	39	61	4647	40	439	2615		1144
1928	1845	102	334	1051	68	230	89	40	64	2277	70	411	6176	386	1471			1448
1929	105	50	71	62	32	44	43	32	37	79	35	46	158	46	77			62
1930	167	33	76	69	7	32	81	27	53	78	25	49	48	13	35			113
1931	1471	50	336	1600	33	239	130	29	76	116	53	83	3176	93	595			1037
1932	287	57	124	458	41	111	1180	61	194	899	111	246	2527	396	1080			1284
1933	88	43	55	104	40	54	74	36	50	119	40	56			227			465
1934	60	39	48	46	29	39	58	35	46									
1935												48	2253	65	594			362
1936	39	12	19	29	8	12	54	14	25	136	30	60	517	57	139			776
1937	223	25	65	279	19	57	193	32	57									
1938	43	27	35	103	26	47	43	25	33	35	25	30	54	27	35	112	20	47
1939	162	16	48	91	29	46	55	22	35	105	21	56	388	24	111	111	24	75
1940	759	65	186	1810	49	195	1203	179	381	2113	140	439	4974	253	940			1950
1941	67	22	33	31	14	22	124	14	47	1214	28	196	2008	266	590	2417	144	459
1942	176	30	62	54	21	32	5616	21	590	2930	130	718	9013	490	1926			823
1943	1319	97	246	430	67	165	858	62	165	135	15	38	308	21	118	359		168
1944	42	27	31	33	15	21	260	15	89	12400	470	1640	1130	413	655	755	359	494
1945	6000	102	780	173	21	92	2090	21	293	173	35	81	935	91	384	620		287
1946			76			69			55			64			70			320
1947	4900	74	408	413	51	110	1470	51	199	173	33	68	135	51	99	3710	135	780
1948	135	33	63	154	21	45	21	15	26	74	21	41	755	21	208			198
1949	135	16	35	21	12	16	60	15	26	413	21	83	173	27	82	4990	237	
1950	237	35	78	610	22	105	80	26	41	215	20	75	3860	46	788	7120	260	1574
MEAN			181			98			117			195			469			667

Note: Flows recorded at Fanshawe Gauge 1915 - 1943 converted to Western University Gauge.

MONTHLY MAXIMUM, MINIMUM AND MEAN DISCHARGES

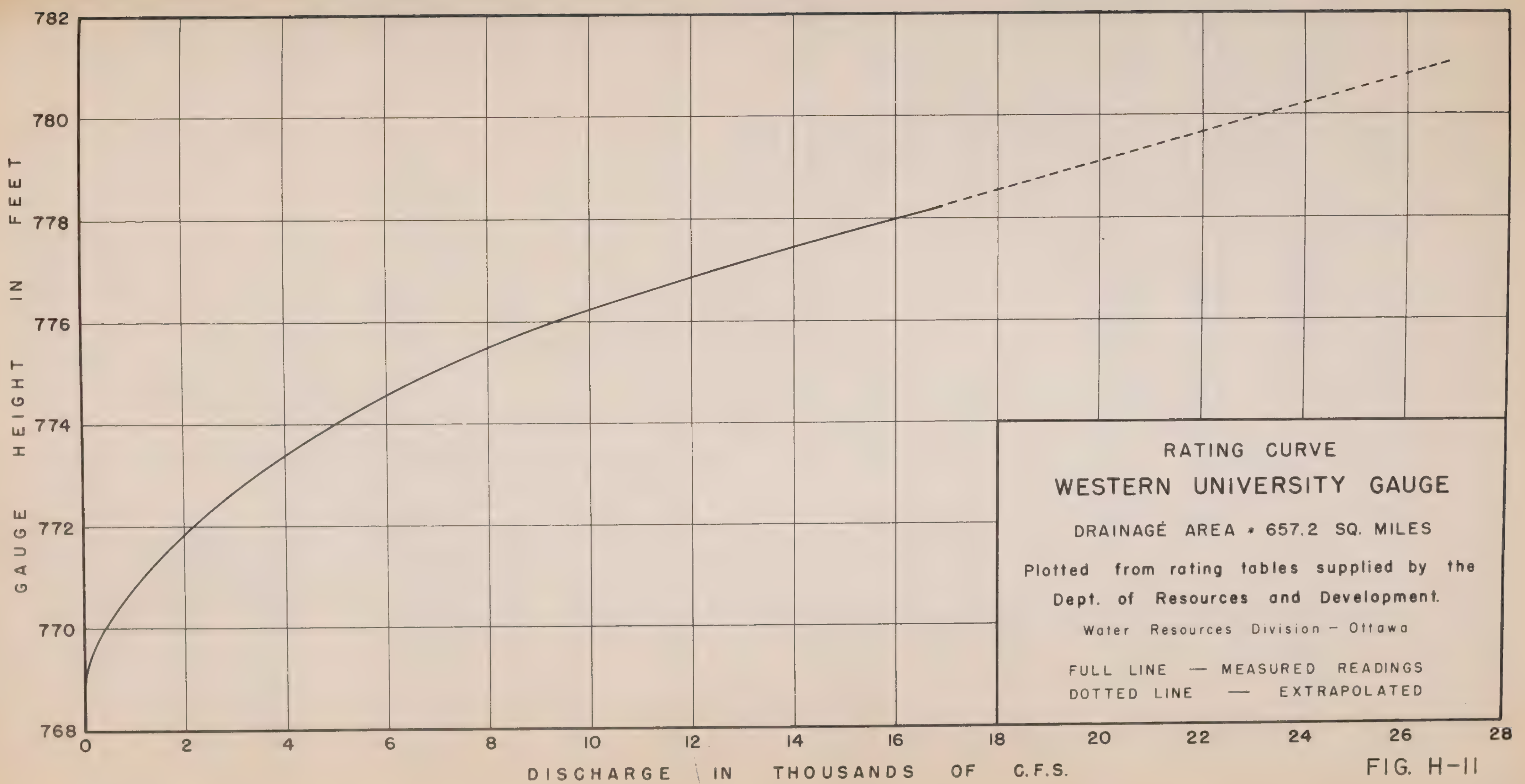
MAIN BRANCH AT BYRON DRAINAGE AREA = 1203.4 SQUARE MILES

YEAR	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915																		
1916	17739	1133	7056	10236	387	1229	15702	442	2564	8944	1337	3299	11250	934	3210	6897	491	1863
1917	1471		436	437		58	19280	525	5039	9699	674	2634	9789	139	2067	7354	495	2047
1918	1212	370	800	3906	19	1953	16895	1943	6201	4517	577	1267	1521	379	644	804	139	343
1919	5476	396	1232	1898	418	804	16219	974	3627	7881	717	2266	10634	717	2703	717	178	405
1920	225	203	210	217	211	216	17660	217	4512	5466	949	1704	1386	188	471	227	148	167
1921	6181	369	1431	1232	268	491	16149	419	3677	14191	679	2559	2698	400	713	616	178	317
1922	6003	227	881	14509	227	2251	5814	745	2087	15901	703	4144	745	253	486	6594	203	929
1923	1870	265	500	354	168	232	9380	306	4340	11980	690	2930	15050	324	1960	2870	189	630
1924	5910	585	1870	1640	433	725	12620	346	3870	8840	710	2830	7210	575	2080	750	240	404
1925	177	103	129	15220	101	2480	16460	715	3670	1220	258	600						
1926			550			520	23190	645	5020	16670	1620	5060	2120	314	720	1530	157	348
1927			499			1430	11220	950	4040	1970	458	840	4460	300	1420	1090	185	409
1928			1590			1220	13620		3060	5630	615	2110	880	208	431			1010
1929			2000			494	26520		6530	18120	1100	3960	6490	690	1980	690	139	254
1930			3530			5360			2370	8520	515	2150	1020	204	487	2070	119	452
1931			120			183	14320		2090	7240	383	2340	1900	204	660	399		198
	No records for the years 1932 to 1937 inclusive.																	
1938				27410	565	6090	16430	610	3500	3040	422	1250	1260	330	550			
1939										13990	815	4220	690	21	318			
1940										20510		6310	6220	335	1440			
1941										5110	355	2010						
1942							17930	2200	5380	3350	260	1350						
1943							30620	665	6160	5800	1100	2480						
1944							6220	325	2650	7100	1050	2550						
1945							10970	795	4560	11370	530	2370						
1946							21260	565	4320	464	236	328						
1947							20840	1810	5090	42350	1010	7220	5760	620	1860			
1948							35700	796	7030	6560	796	2040	8330	404	2120	434	236	351
1949							19400	752	3220	2830	464	1190	886	24	360			
1950							25280			30500								
MEAN									4184			2643			1270			

YEAR	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1915													4641	323	1282	2882	442	1153
1916	423	73	265	231	81	124	231	72	111	423	73	190	577	53	179	1332	120	664
1917	7702	178	2569	495	53	279	254	21	138	1560	53	483	1183	246	488	1232	254	650
1918	294	21	126	139		44	805	12	386	538	53	246	760	380	522	9193	418	1868
1919	217	12	87	217	12	67	457	12	102	635	148	241	3975	320	569	3250	227	525
1920	1511	148	337	569	84	193	227	98	141	511	148	253	2444	320	838	4174	679	1729
1921	8666	96	842	226	134	174	308	134	187	1481	178	460	3533	227	890	19747	539	2231
1922	467	207	310	439	100	229	712	80	305	388	189	257	342	201	249	416	135	232
1923	756	150	213	300	162	200	1410	218	419	340	230	262	840	245	435	9560	1370	2890
1924	760	206	315	1430	194	442	358	194	249	342	139	192	167	109	141			266
1925										258	103	162	4490	204	1220	4060		680
1926	167	96	115	3360	100	635	5540	200	1240	5450	525	1680	14150	1550	4170			835
1927	13360	142	1430	760	154	241	258	130	183	1100	170	311	6350	185	845			2150
1928			615			445			177			760	7440	735	2250			2230
1929			175			118			106			147			273			177
1930	236	63	131			92			114	560	60	146			123			202
1931			605			344			206									
1938																		
1939																		
1940																		
1941																		
1942							Flood discharges only recorded 1938 - 1950											
1943																		
1944																		
1945																		
1946																		
1947																		
1948																		
1949																		
1950																		
MEAN																		

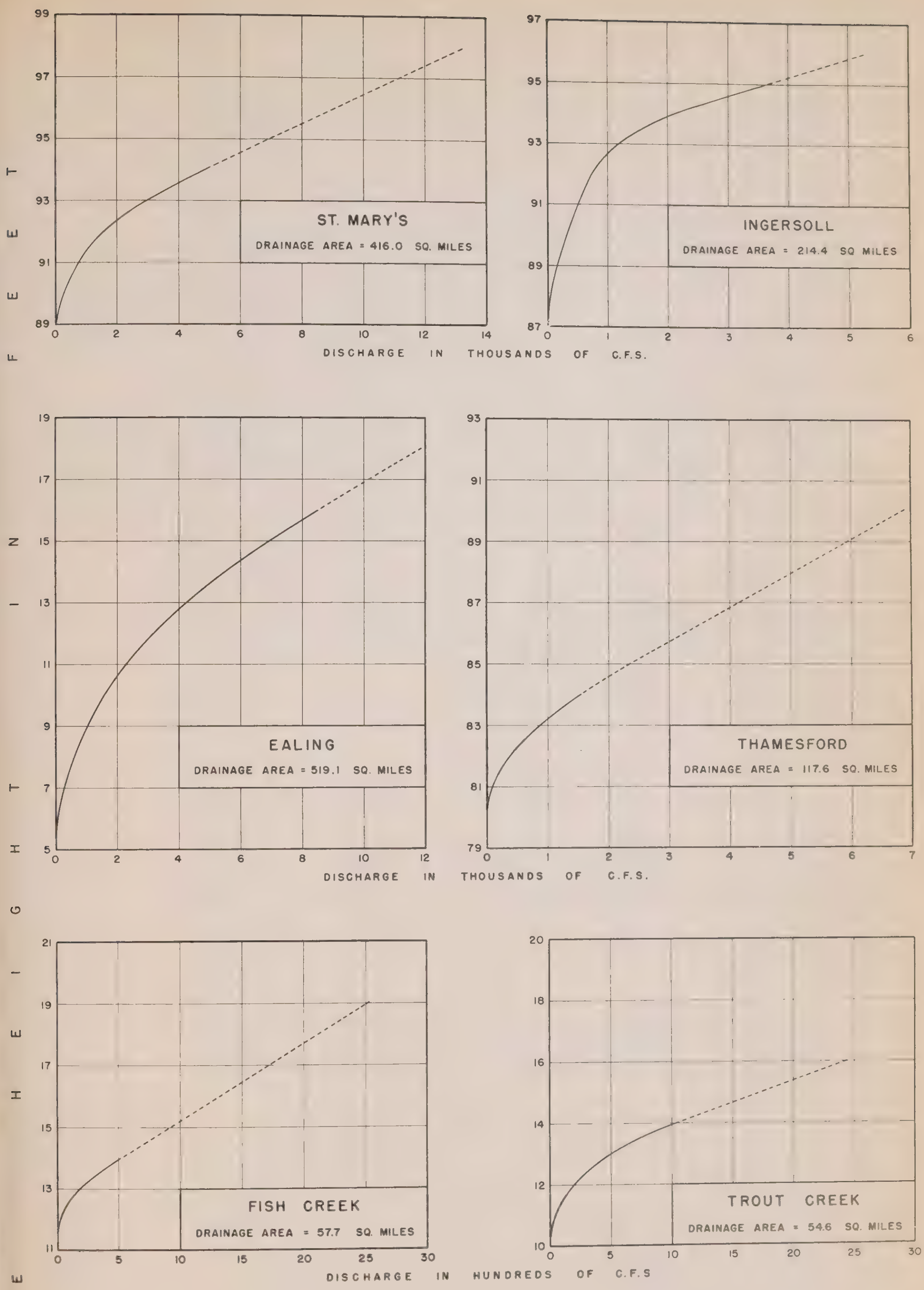
Note: Flows recorded at Kilworth Gauge 1915 - 1922 converted to Byron Gauge.

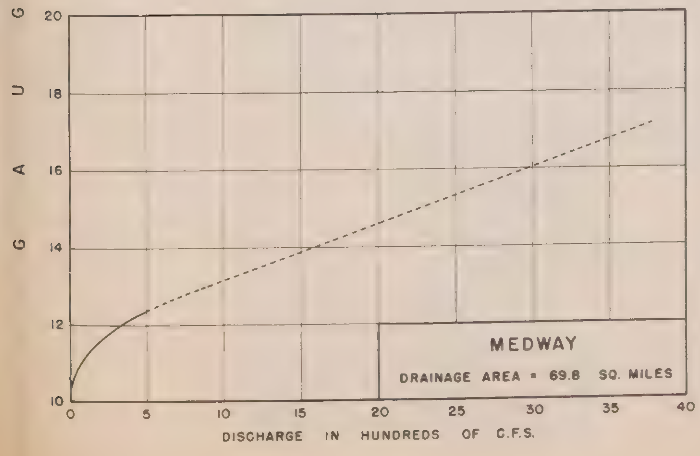
TABLE H-8



RATING CURVE
WESTERN UNIVERSITY GAUGE
DRAINAGE AREA * 657.2 SQ. MILES
Plotted from rating tables supplied by the
Dept. of Resources and Development.
Water Resources Division – Ottawa
FULL LINE — MEASURED READINGS
DOTTED LINE — EXTRAPOLATED
782
780
778
776
774
772
770
768
GAUGE HEIGHT IN FEET
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
DISCHARGE IN THOUSANDS OF C.F.S.

FIG. H-11





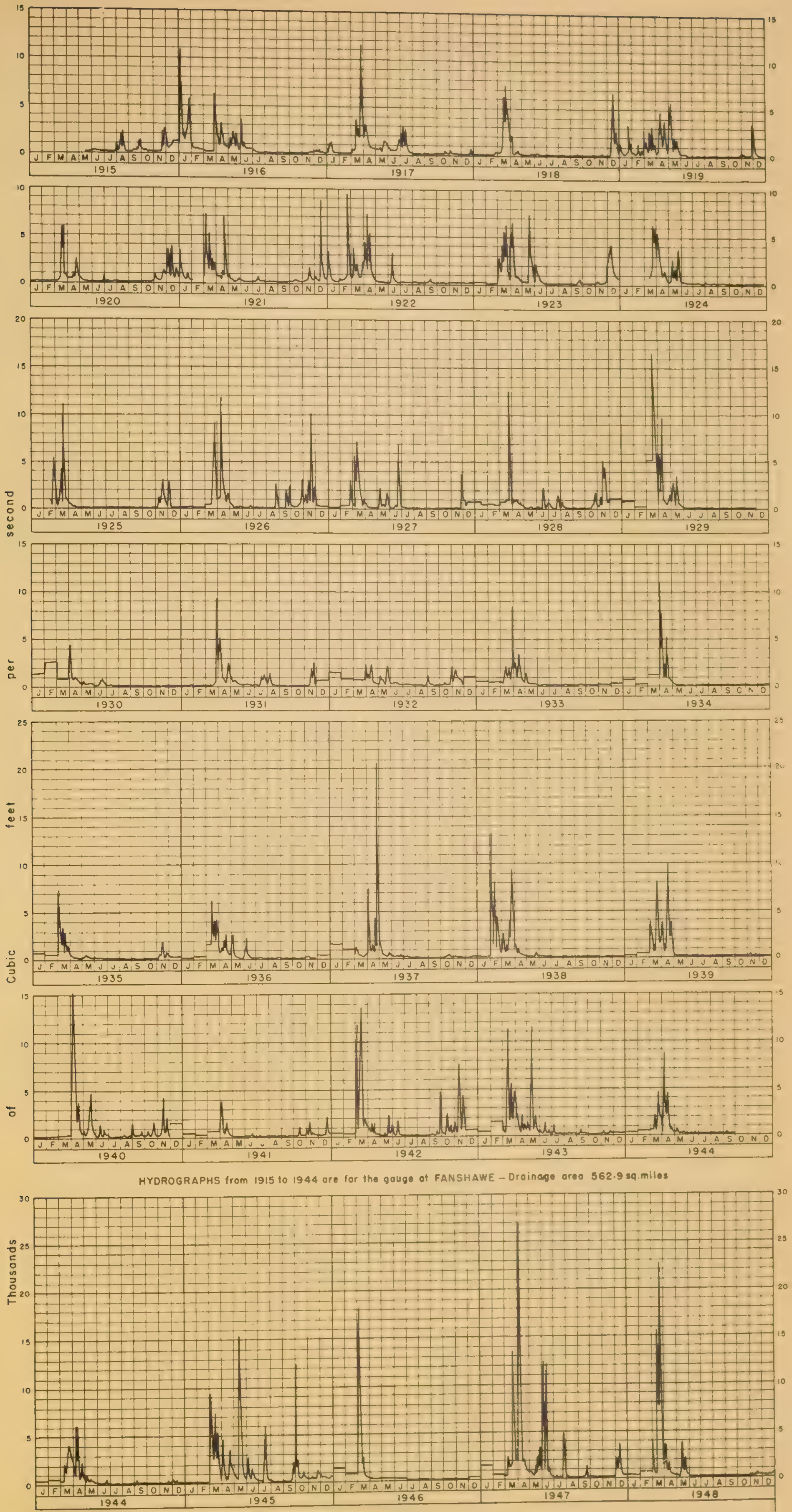
RATING CURVES FOR GAUGES

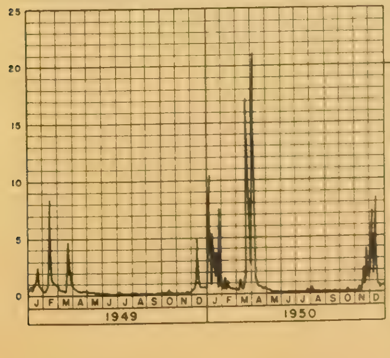
ABOVE THE CITY OF LONDON

Plotted from rating tables supplied by the Dept. of Resources and Development. Water Resources Division — Ottawa

FULL LINES — MEASURED READINGS
DOTTED LINES — EXTRAPOLATED

FIG. H-12





HYDROGRAPHS from 1944 to 1950 are for the gauge at WESTERN UNIVERSITY
Drainage area 657·2 sq.miles

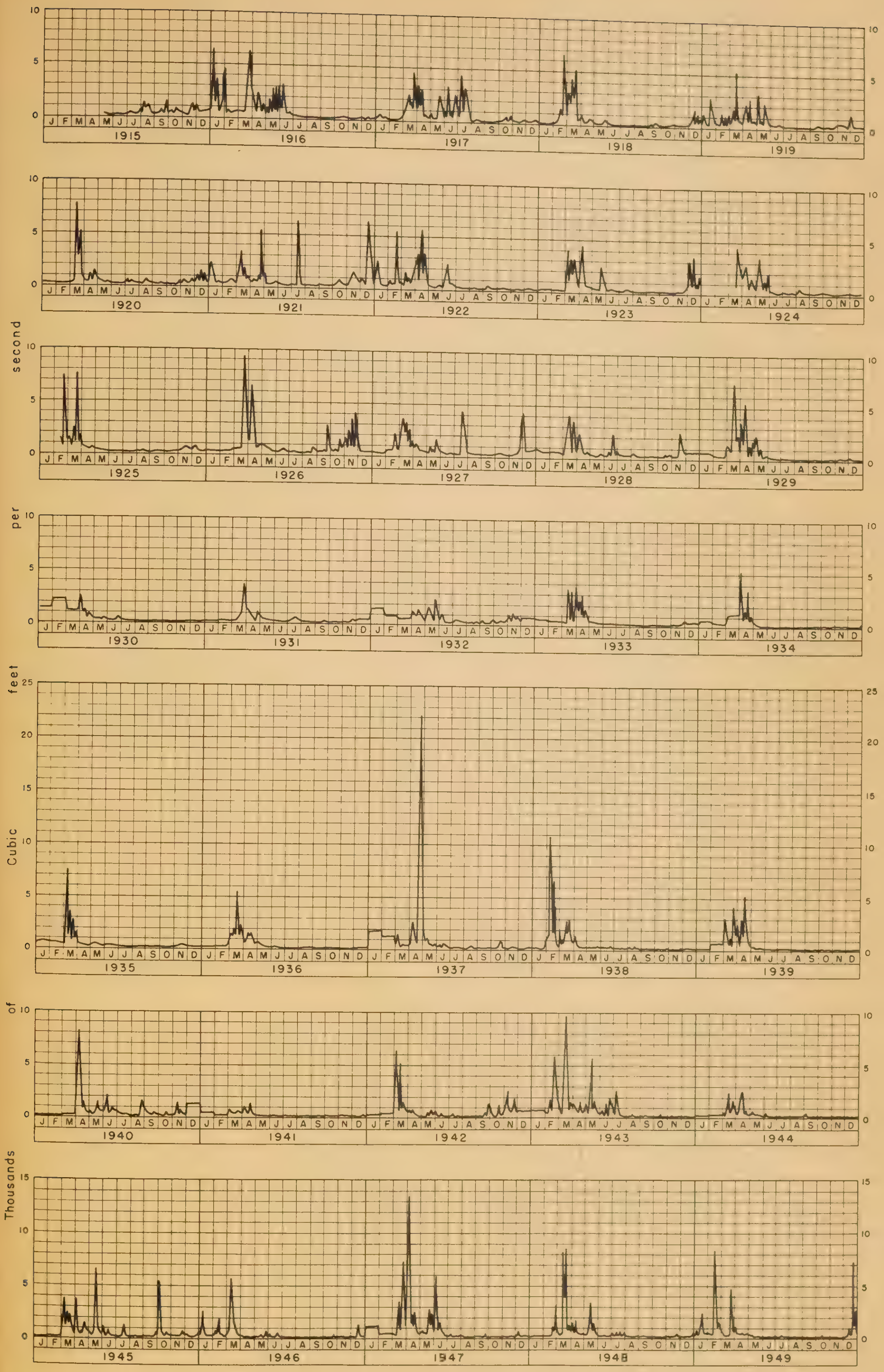
HYDROGRAPHS

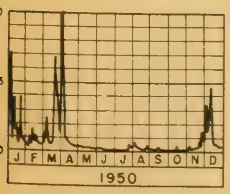
Gauges at FANSHAWE & WESTERN UNIVERSITY

Gauge established at WESTERN UNIVERSITY October. 1943
Gauge at FANSHAWE discontinued 1944

Mean daily flows plotted from records of the Water Resources Division
Department of Resources & Development. OTTAWA

FIG. H-13



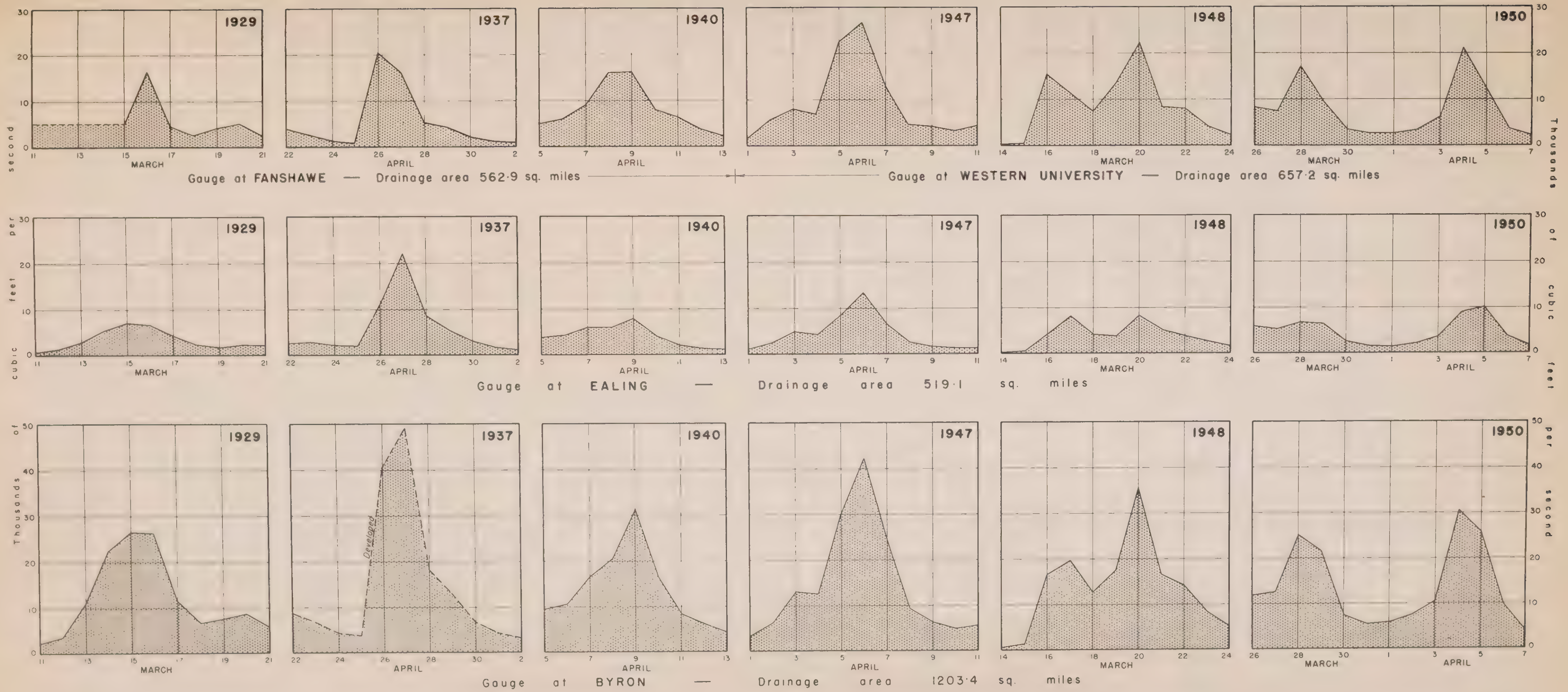


HYDROGRAPHS

Gauge at EALING – Drainage area 519·1 sq. miles

Mean daily flows plotted from records of the Water Resources Division
Department of Resources & Development, OTTAWA

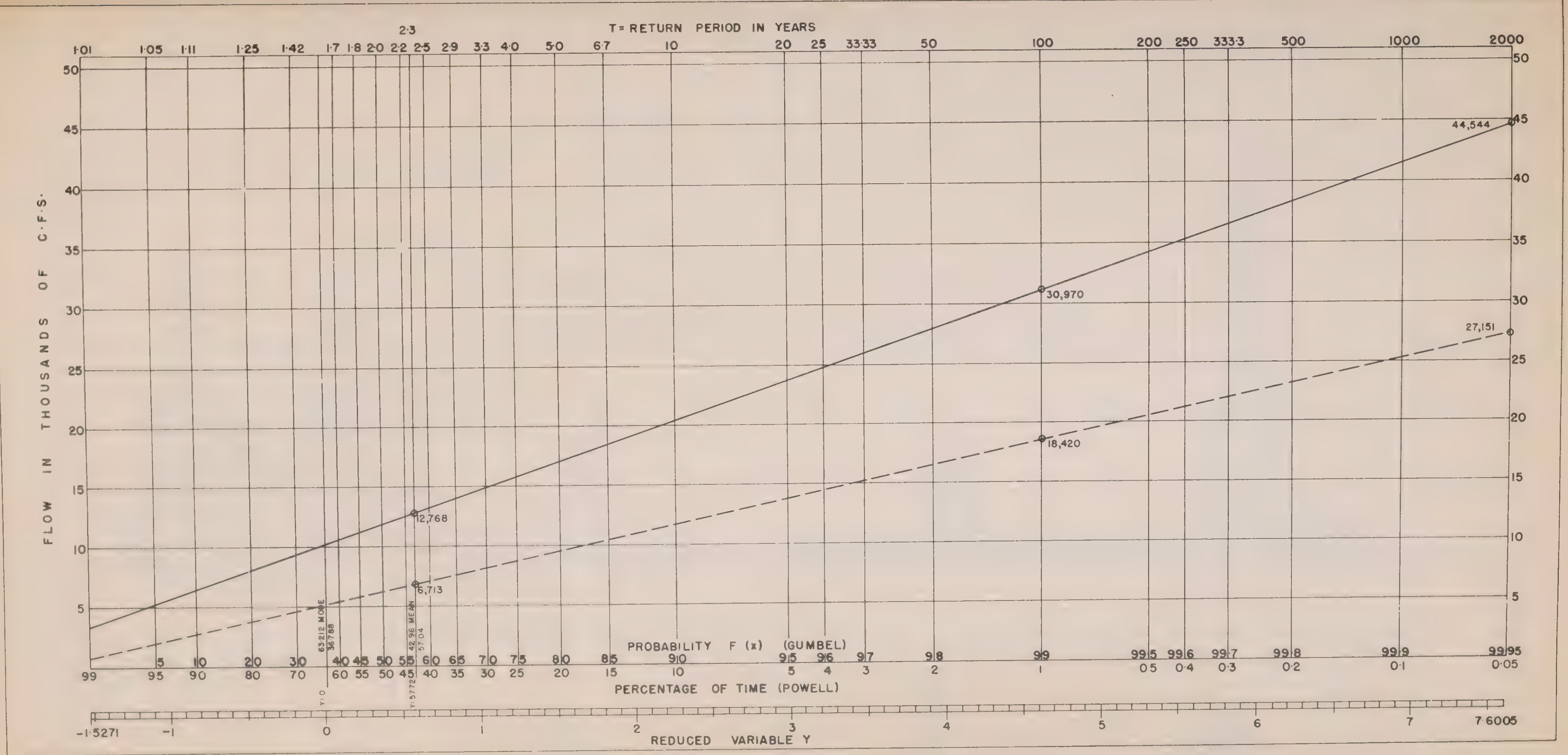
FIG. H-14



FLOOD HYDROGRAPHS

Mean daily flows plotted from records of the Water Resources Division, Department of Resources & Development, OTTAWA

FIG. H-15



NOTE
FANSHAWE DISCHARGES 1916 – 1943
CONVERTED TO WESTERN UNIVERSITY

FREQUENCY CURVES
MAXIMUM MEAN DAILY FLOWS
FIG. H-16

LEGEND
NORTH BRANCH AT WESTERN UNIVERSITY ········ ———
SOUTH BRANCH AT EALING ················ — — —

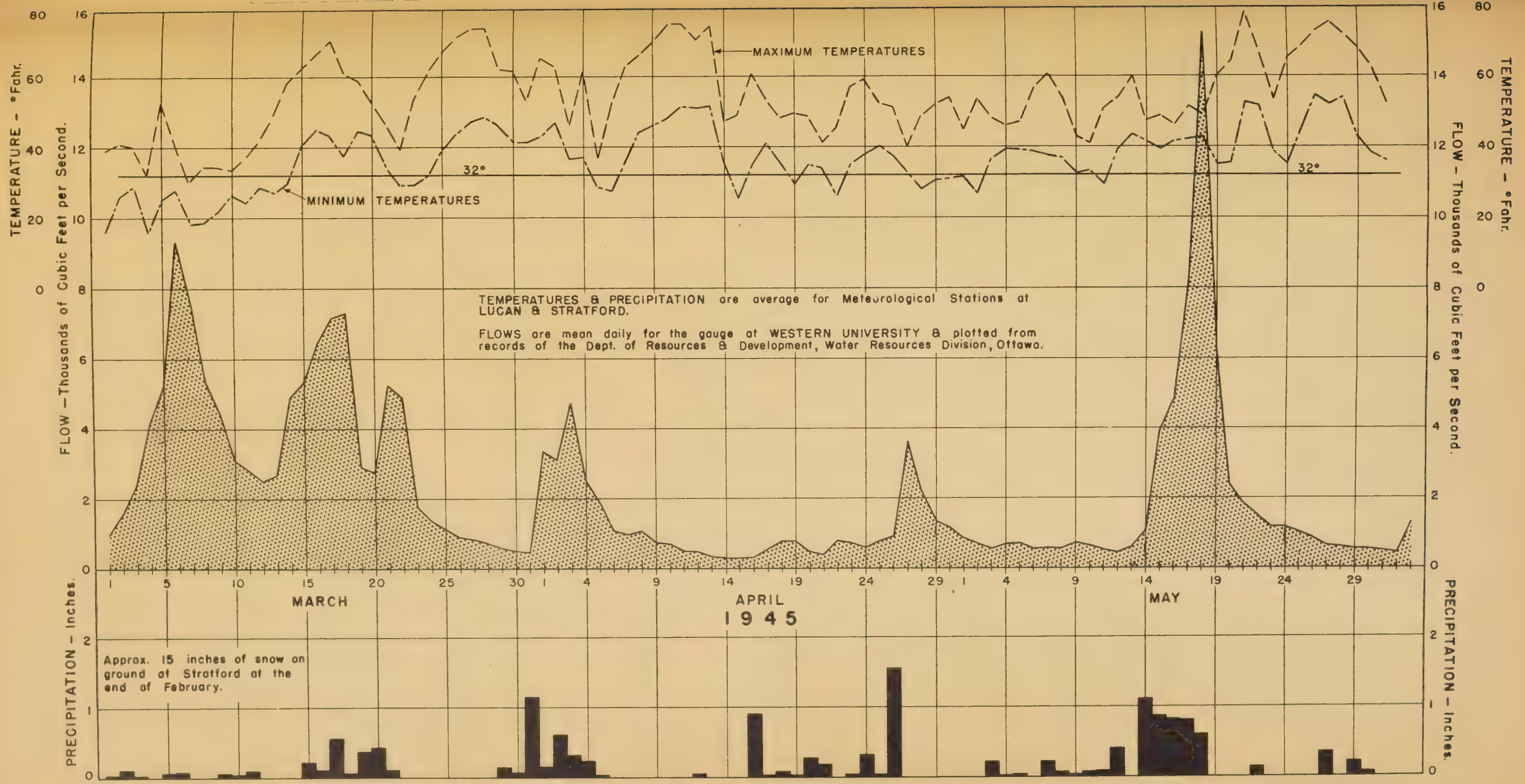
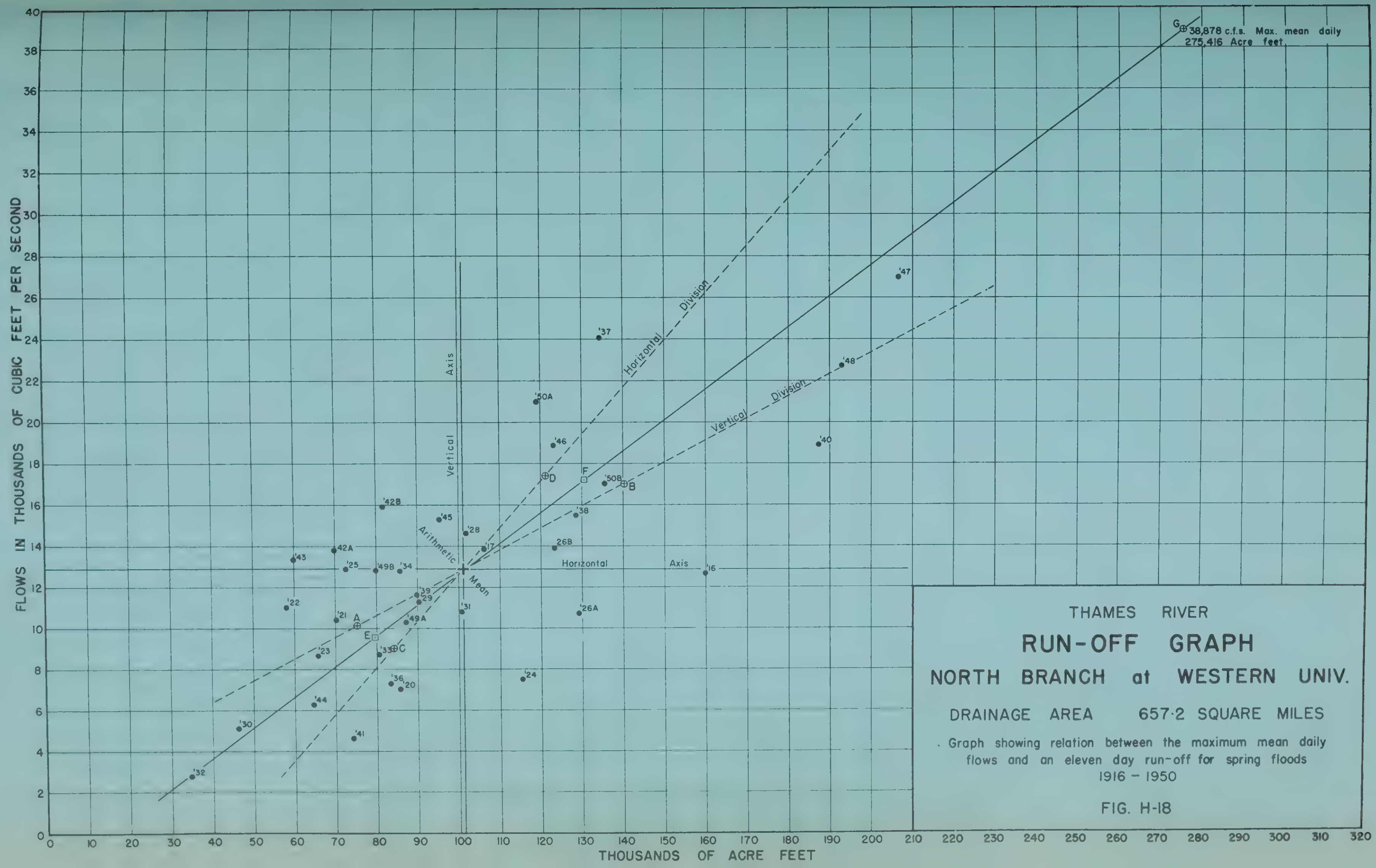


DIAGRAM SHOWING the INFLUENCE of PRECIPITATION and TEMPERATURE on RUN-OFF

FIG. H-17



THAMES RIVER

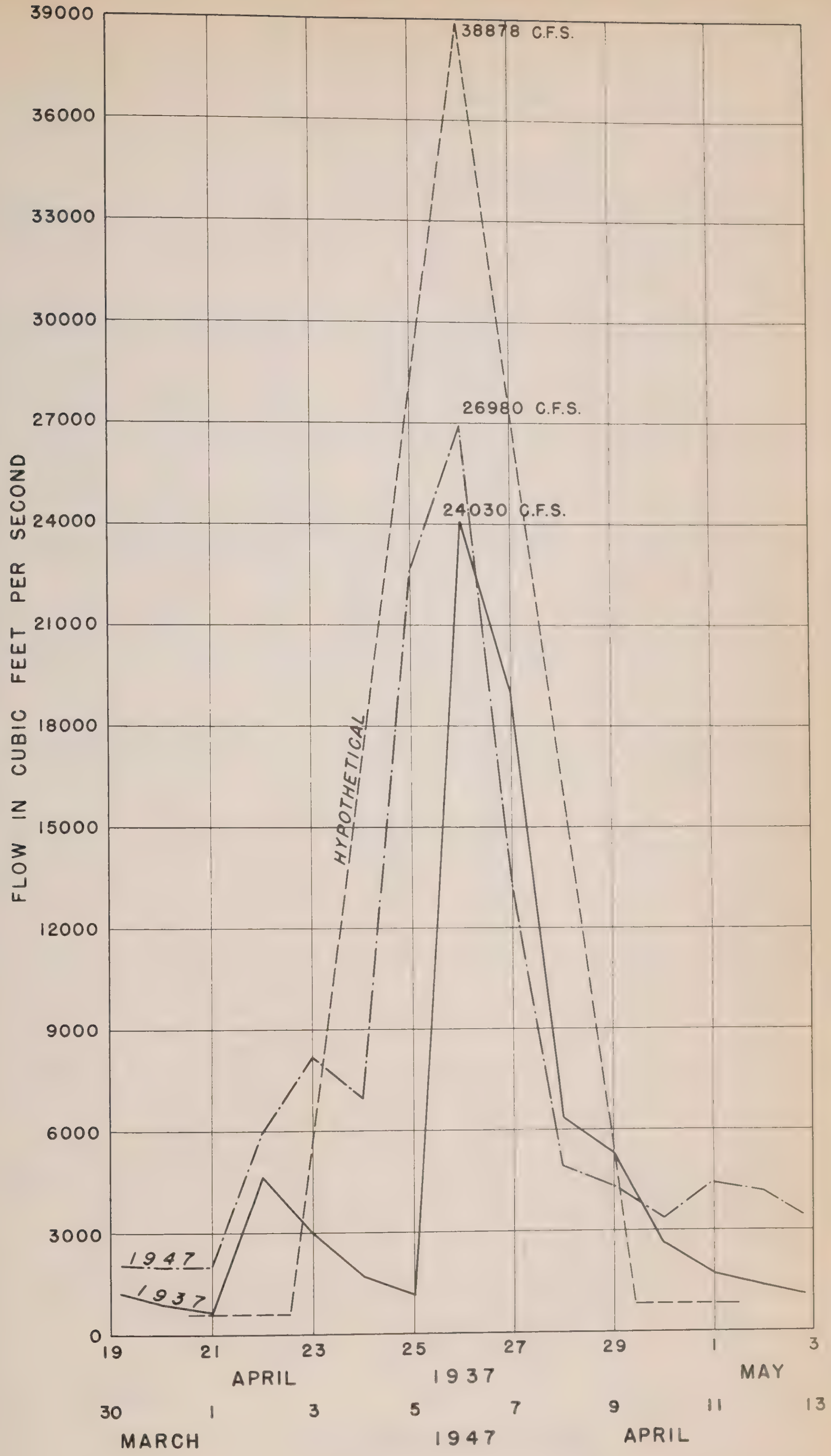
RUN-OFF GRAPH

NORTH BRANCH at WESTERN UNIV.

DRAINAGE AREA 657·2 SQUARE MILES

Graph showing relation between the maximum mean daily flows and an eleven day run-off for spring floods 1916 – 1950

FIG. H-18



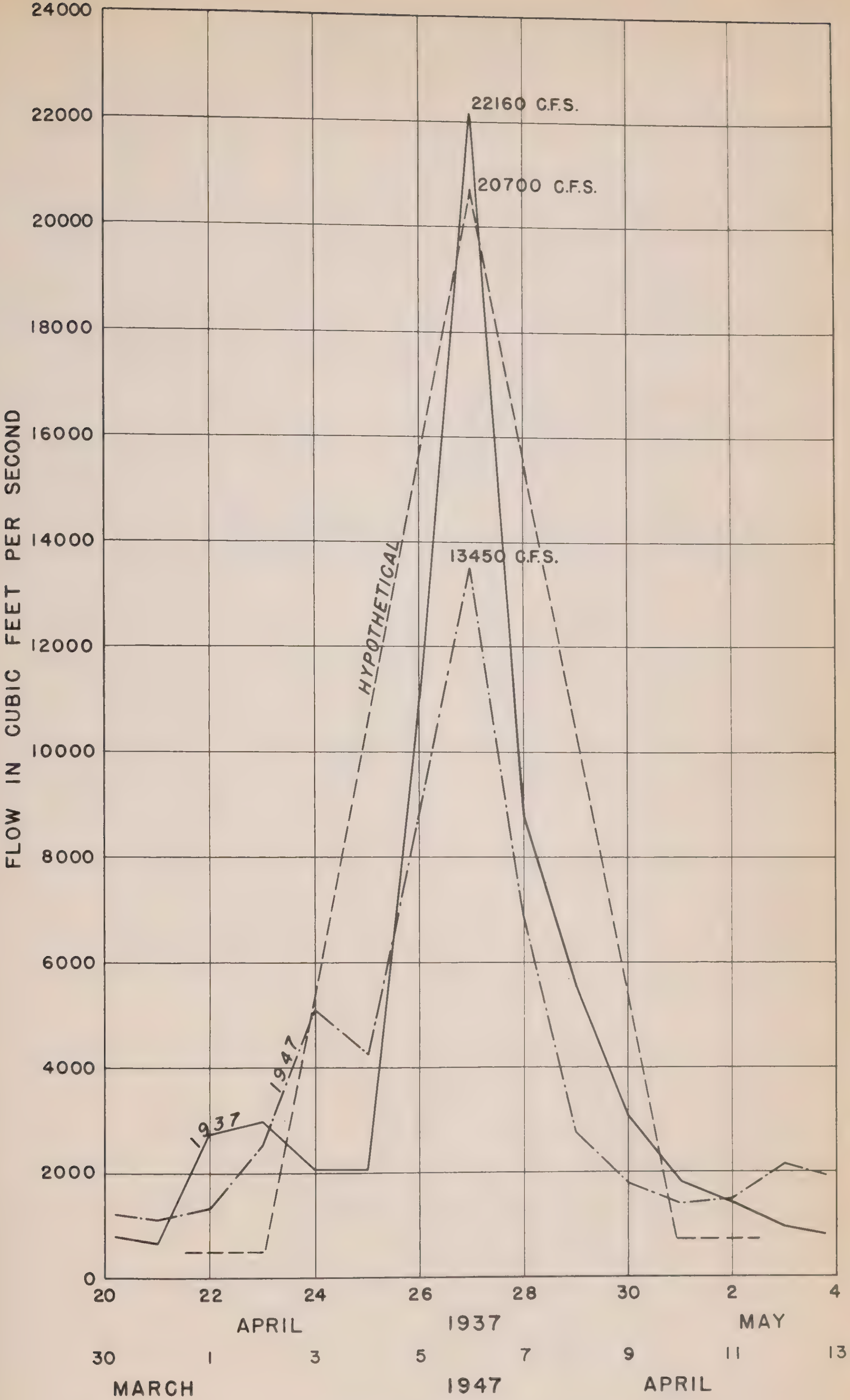
HYDROGRAPHS

NORTH BRANCH at WESTERN UNIV.

DRAINAGE AREA 657·2 SQUARE MILES

Mean daily flows plotted from Dept. of Resources & Development Water Resources Division records.
(1937 Flow records for Fanshawe converted to Western Univ.)

FIG. H-20



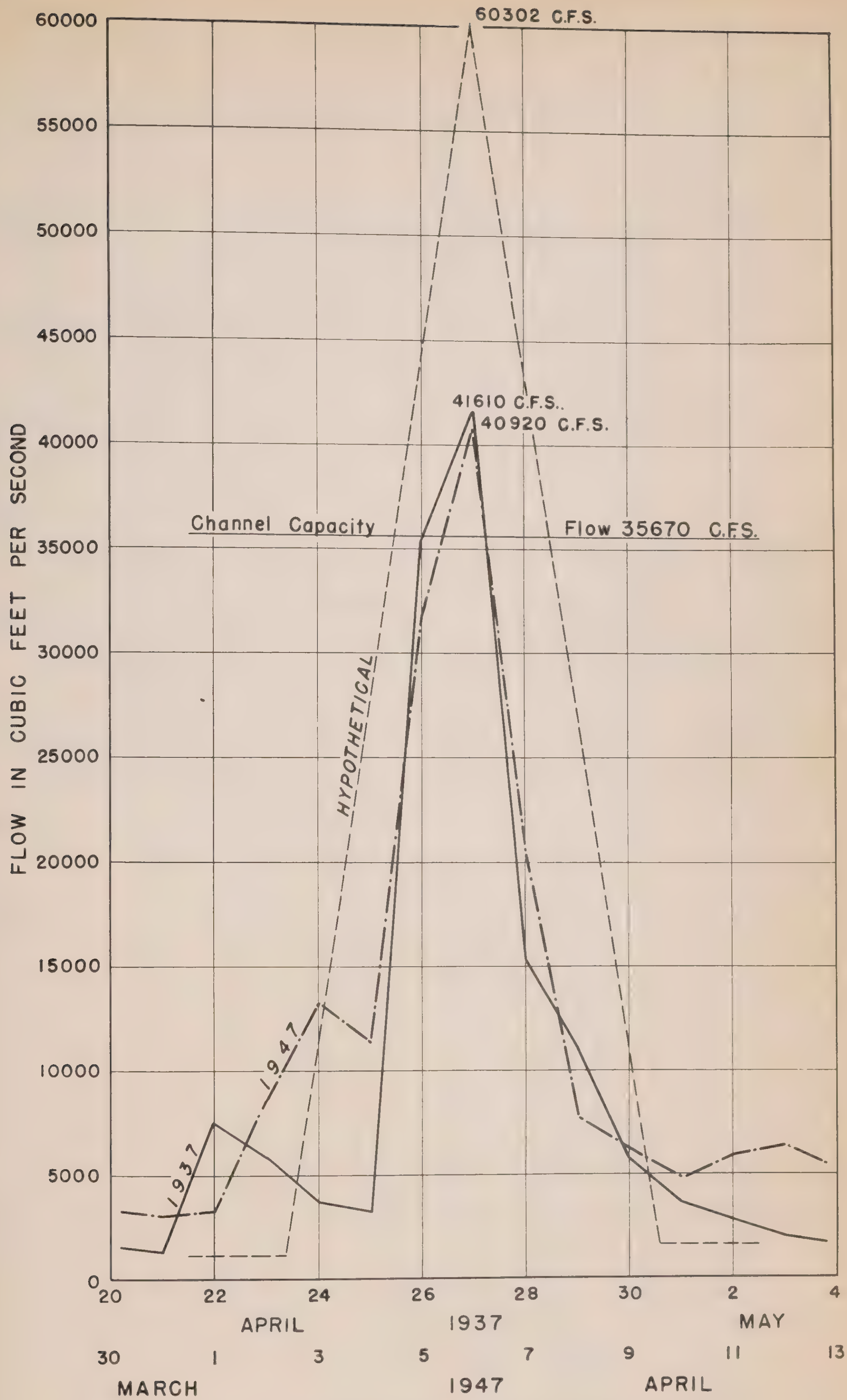
HYDROGRAPHS

SOUTH BRANCH at EALING

DRAINAGE AREA 519·1 SQUARE MILES

Mean daily flows plotted from Dept. of Resources & Development Water Resources Division records.

FIG. H-21



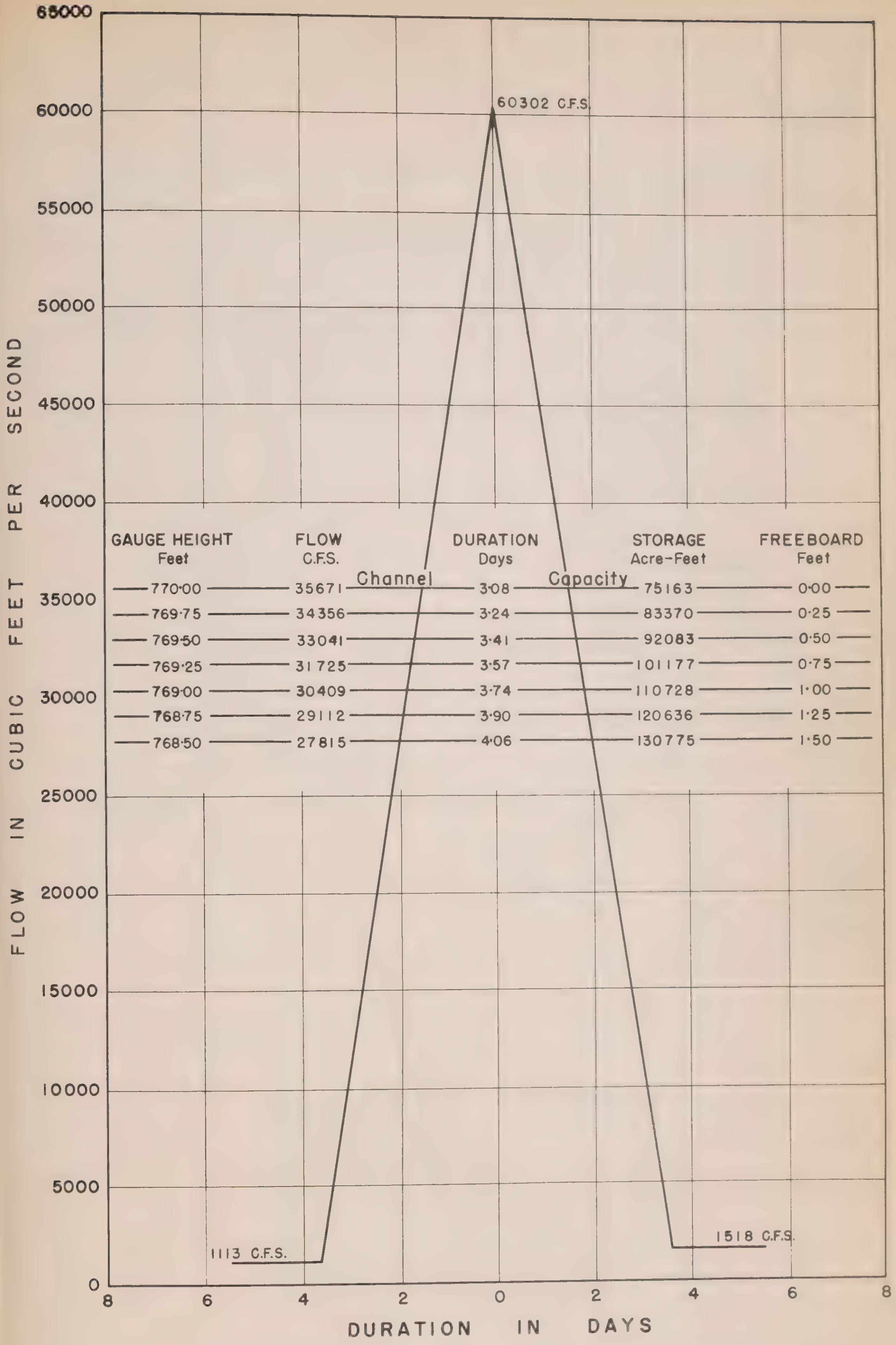
HYDROGRAPHS

CONFLUENCE of NORTH & SOUTH BRANCHES

DRAINAGE AREA 1190·6 SQUARE MILES

Mean daily flows at Ealing & Western Univ. combined & adjusted by ratio of areas to give approximate flow at Forks.

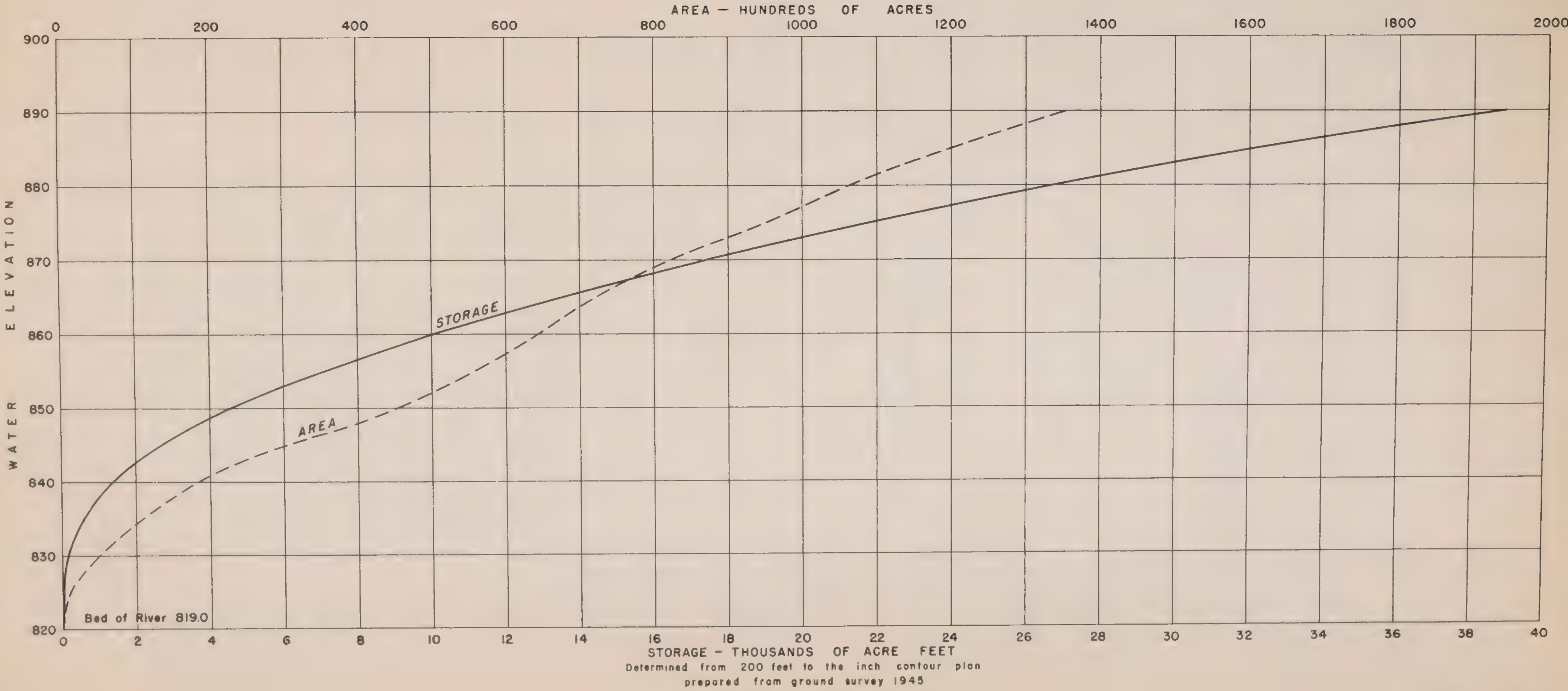
FIG. H-22



HYPOTHETICAL HYDROGRAPH for LONDON

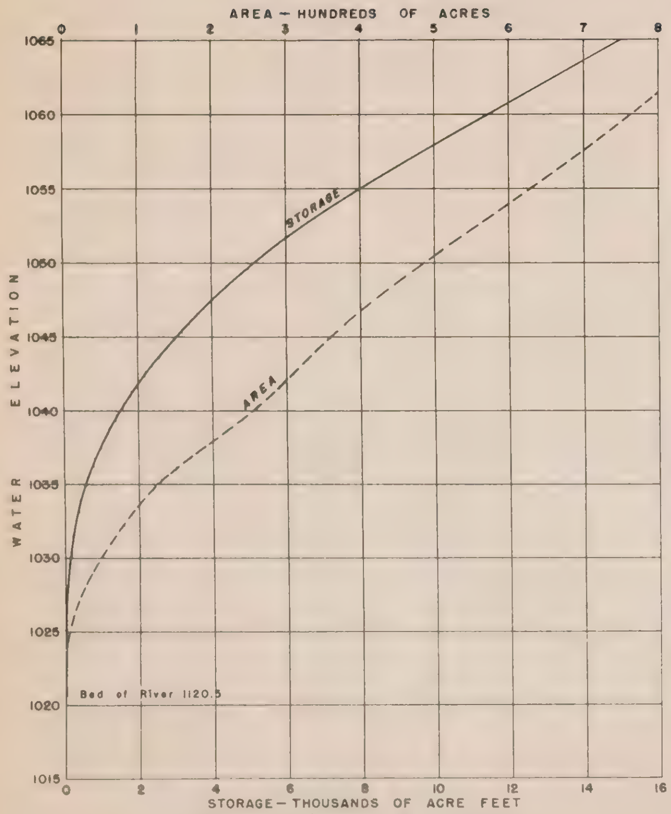
Showing Storage required for Channel Capacity Flow and for various stages of Freeboard below the Channel Capacity Flow.

FIG. H-23



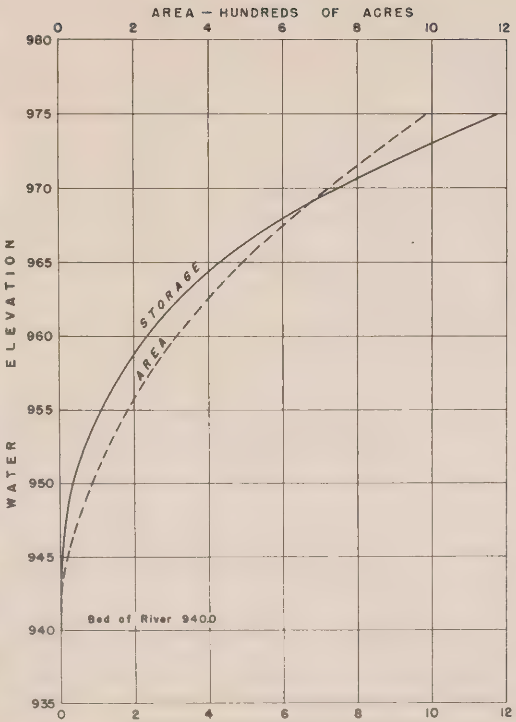
FANSHAWE RESERVOIR
STORAGE & AREA CURVES

FIG. H-24



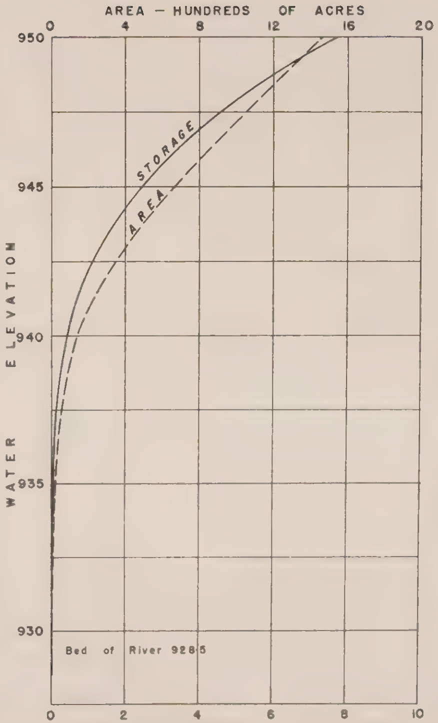
Determined from 200 feet to the inch contour pla[n] prepared from ground survey 1945.

WILDWOOD RESERVOIR
STORAGE & AREA CURVES



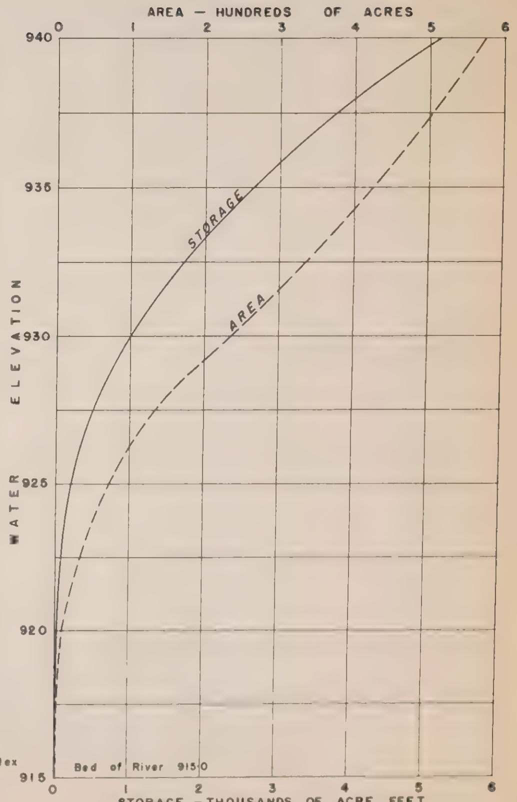
Determined from a 1000 feet to the inch contour plan prepared by the Stereo-Comparagraph from aerial photographs with altimeter (Wallace & Tiernan type F.A. 176) and levelled control.

FISH CREEK RESERVOIR
STORAGE & AREA CURVES



Determined from 200 feet to the inch contour plan prepared from aerial photographs by means of the Multiplex Projector. Horizontal and vertical control by Stadia M.H.I. with basic level control.

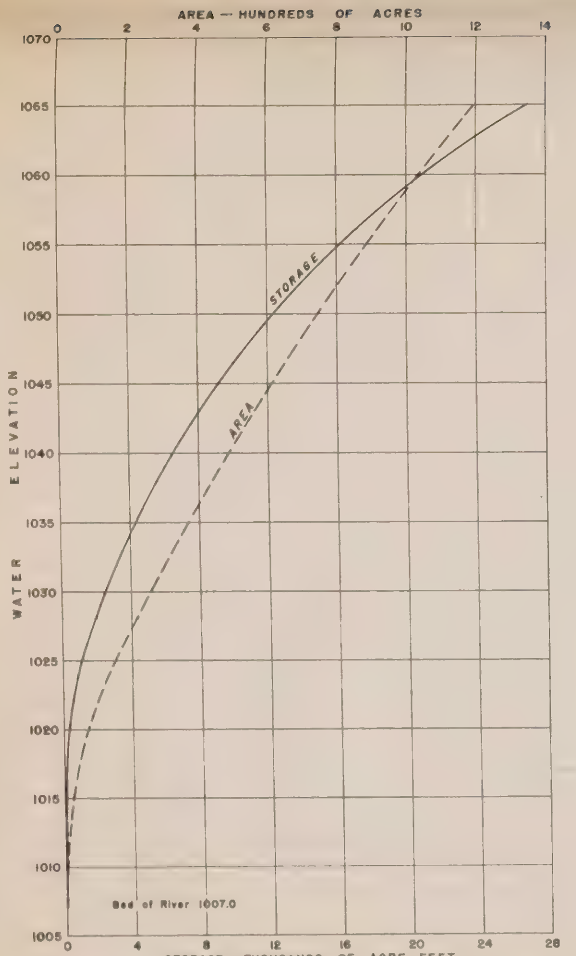
CEDAR CREEK RESERVOIR
STORAGE & AREA CURVES



Determined from 200 feet to the inch contour plan prepared from aerial photographs by means of the Multiplex Projector. Horizontal and vertical control by Stadia M.H.I. with basic level control.

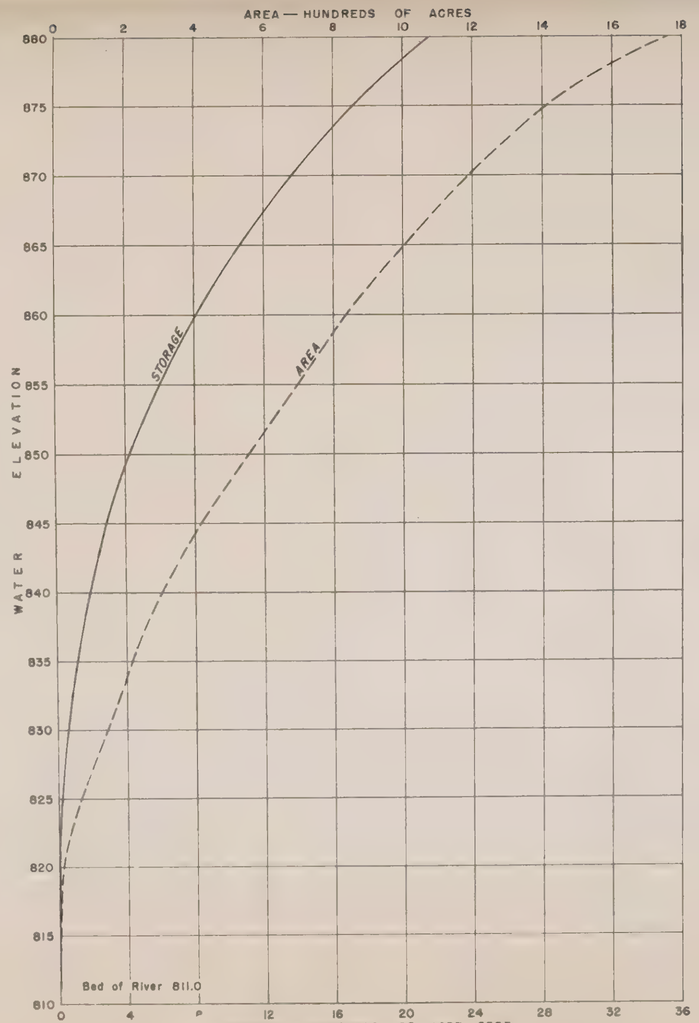
WOODSTOCK RESERVOIR
STORAGE & AREA CURVES

FIG H-25



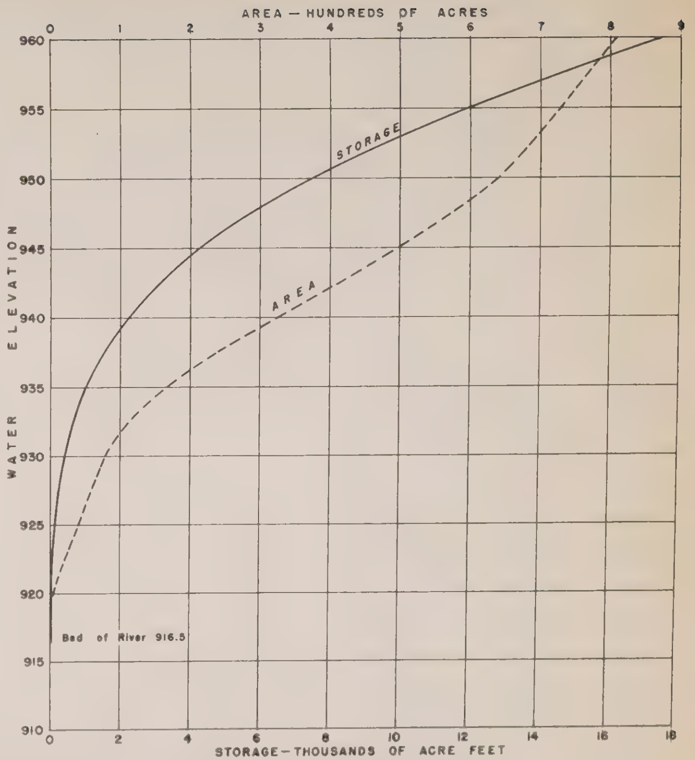
STORAGE — THOUSANDS OF ACRE FEET
Storage and Area approximate only — determined from 1000 feet to the inch incompleted contour plan prepared by G. G. Reid, Consulting Engineer

GLENGOWAN RESERVOIR
STORAGE & AREA CURVES



STORAGE - THOUSANDS OF ACRE FEET
Determined from 200 feet to the inch contour plan prepared from aerial photographs by means of the Multiplex Projector. Horizontal and vertical control by Stadia M.H.I. with basic level control

MEDWAY RESERVOIR
STORAGE & AREA CURVES



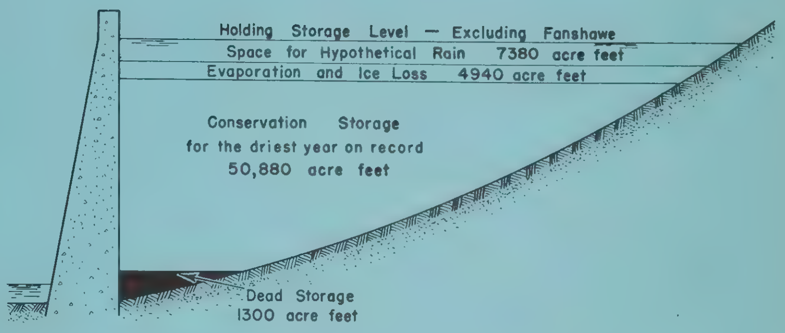
STORAGE — THOUSANDS OF ACRE FEET
Determined from 400 feet to the inch contour plan prepared from ground survey 1945

THAMESFORD RESERVOIR
(LOWER DAMSITE)
STORAGE & AREA CURVES

FIG. H-26

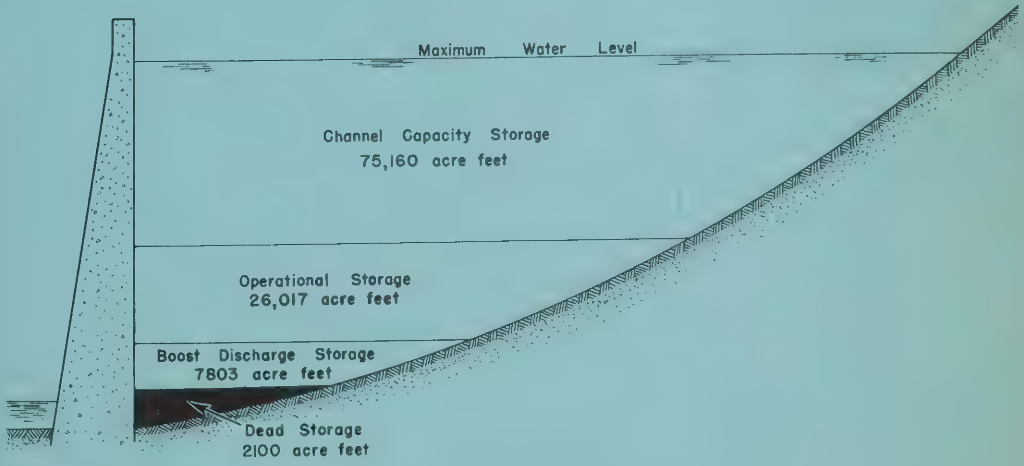
DIAGRAMS ILLUSTRATING THE TOTAL SPACE FOR:

CONSERVATION STORAGE



The Conservation Storage reserved space and allowances at the beginning of the Drawdown Period of 273 days for the driest year on record

FLOOD STORAGE



The storage classifications for the Spring Filling Period

FIG. H-27

CHAPTER 6

DRAINAGE

Generally speaking, it has always been assumed that the results of drainage are beneficial and that all properties affected by any drainage scheme are benefited in a greater or smaller degree. Throughout the period of settlement in Southern Ontario this was true to a certain extent as drainage enabled more land to be brought under cultivation, which meant more crops and greater prosperity to the community; also, in many instances, it enabled farmers to work the land earlier in the spring than they would have been able to do otherwise. All drainage legislation to date has been based on this assumption and has resulted in many drainage schemes being extended, not only beyond the bounds of economic feasibility, but even beyond the limits of physical practicability.

The result is that, in many cases, drains have been pushed into areas where they not only do not serve the purpose for which they were intended but actually are a detriment to the welfare of the community by draining water out of natural water storage areas such as swamps and bogs without creating soil conditions dry enough for cultivation or even the maintenance of worth while pasture.

This draining of swamps and bogs means that the water is not available to maintain adequate summer flow in the streams and has also lowered the water table to such a point that wells have gone dry as a direct result of draining. For example, farmers, whose properties border on the Ellice Swamp, were hauling water for cattle in the summer of 1948 for the first time in living memory.

On the South Nation River attempts have been made to drain areas where the rock surrounding them makes drainage impossible or, at best, prohibitively expensive.

Some drainage schemes are necessary and beneficial, others are ill-considered and unwise, therefore, no drainage

scheme should be undertaken without due consideration of all the physiographic and economic features, indeed the Kennedy Report[1] makes the following recommendations:

(a) That no drainage project be undertaken until its probable effect upon the community as a whole has been considered by a board of referees, composed of judicial and engineering personnel, as well as practical farmers, and the approval of such board obtained.

(b) That no single landowner or small group of owners may be enabled to force an unwanted and even detrimental drainage scheme on neighbouring owners without their consultation and consent.

(c) That the cost of the work will be equitably distributed among the landowners actually benefited.

(d) That provision be made for payment of compensation to those injuriously affected, and

(e) That Municipalities have power to expropriate areas which it is proposed to drain, when the welfare of the community requires that the area in question should be maintained in its existing state.

The accompanying table shows that a total of at least 850 miles of drains have been constructed on the Upper Thames Watershed and that at least $1,431,793 has been spent on the work. This figure does not give the whole story as records of the costs of the early drains were not available. In addition, many Municipal Drains were originally Award Ditches which have been converted to drains in recent years, so that the original cost of construction and maintenance in early years is not included.

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1. Ontario Royal Commission on Forestry. 1947.

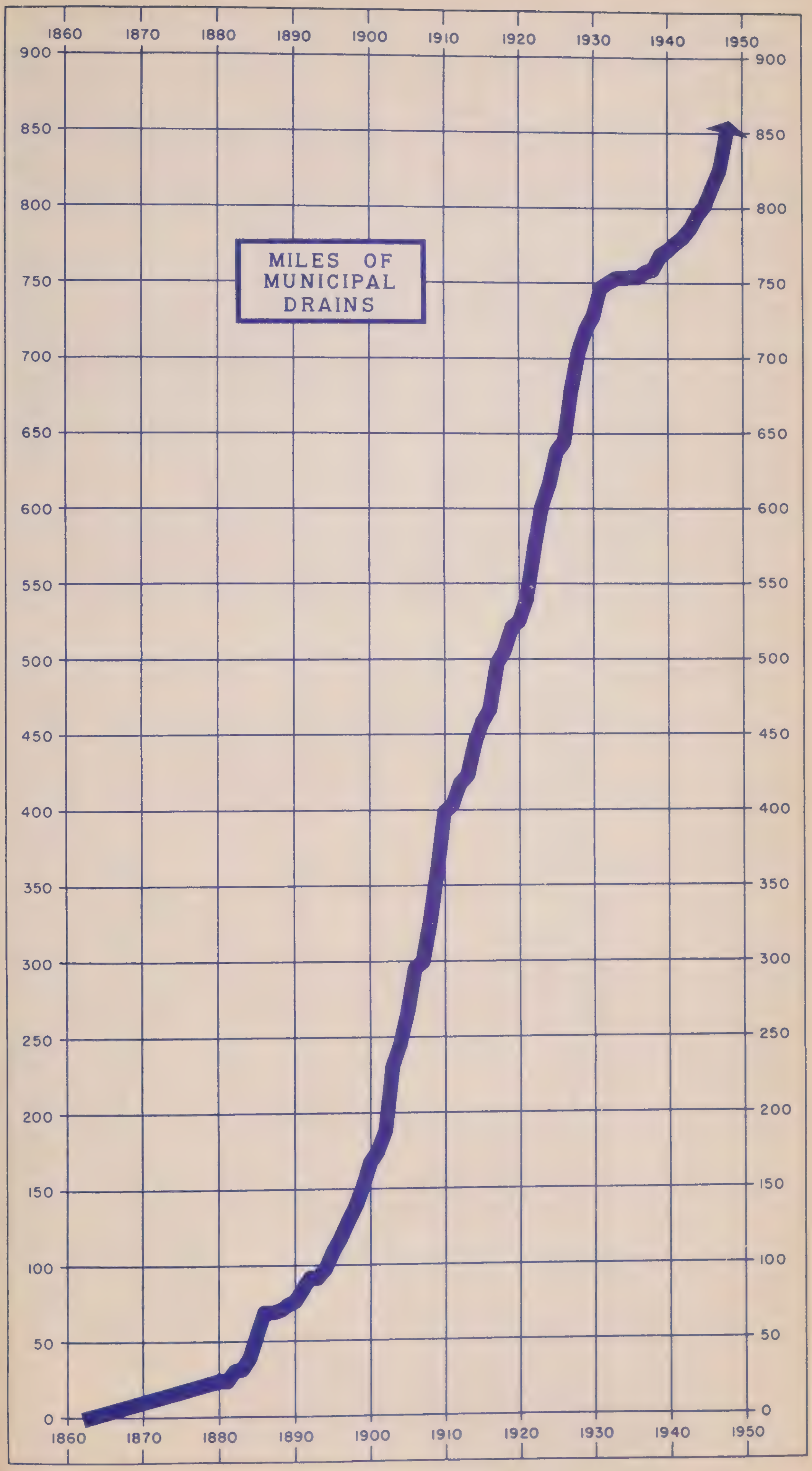
Another point worth noting is that the cost of maintenance work is continually rising; for example, in one particular case, a drain 5 miles long cost $3,502 to construct in 1910; twenty years later, in 1930, it cost $6,539 to clean out; and fourteen years later cost another $4,732.

The average cost of drains on the watershed has been over $1,500 per mile. When sums as large as this are involved, it would be advisable to have a very careful study made beforehand by a land use expert who could decide whether the land to be drained would repay the money expended in increased crop returns.

Every Conservation Authority should investigate any drainage scheme which is proposed within its boundaries, and have a representative present at the presentation of the engineer's report as provided by The Municipal Drainage Act R.S.O.1950, c.246 s.8(13).

MUNICIPAL DRAINS - UPPER THAMES WATERSHED

Township	Number of Drains	Length in Miles	Cost $
Biddulph	3	13.24	9,676
Blandford	26	38.33	46,566
Blanshard	12	18.82	40,138
Dereham	37	67.02	100,020
Dorchester North	11	27.92	23,859
Dorchester South	1	1.32	705
Downie	17	45.85	71,929
Easthope North	9	28.09	57,176
Easthope South	14	19.71	48,039
Ellice	38	118.14	245,760
Fullarton	22	52.86	53,613
Hibbert	9	16.56	17,246
Lobo	1	1.25	2,224
Logan	22	89.36	147,370
London	17	33.69	78,888
Nissouri East	7	10.97	17,397
Nissouri West	12	30.35	46,244
Oxford East	15	21.35	30,176
Oxford North	14	21.47	29,268
Oxford West	30	38.49	50,757
Usborne	7	11.53	28,094
Westminster	16	41.40	82,497
Zorra East	59	85.72	104,063
Zorra West	53	66.05	97,104
Total	452	899.51	1,428,809


MILES OF MUNICIPAL DRAINS
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900

MUNICIPAL DRAINS
OF THE
UPPER THAMES RIVER WATERSHED
1948
FROM DATA SUPPLIED BY MUNICIPAL CLERKS
NATURAL STREAM CHANNELS
SCALE - MILES
1 0 1 2 3 4 5
ONTARIO DEPARTMENT OF PLANNING AND DEVELOPMENT
CONSERVATION BRANCH
BLANDFORD TOWNSHIP
ELMA
McKILLOP
MORNINGTON
LOGAN
MITCHELL
ELLICE
EASTHOPE NORTH
STRATFORD
EASTHOPE SOUTH
HIBBERT
FULLARTON
DOWNIE
AVON RIVER
THAMES RIVER
USBORNE
BLANSHARD
ZORRA EAST
BLANDFORD
ZORRA WEST
NISSOURI EAST
BIDDULPH
OXFORD EAST
OXFORD WEST
NISSOURI WEST
NORTH BRANCH
INGERSOLL
LONDON
OXFORD NORTH
NORWICH NORTH
DEREHAM
DORCHESTER NORTH
DORCHESTER SOUTH
WESTMINSTER
LOBO
CARADOC
DELAWARE

CHAPTER 7

COMMUNITY PONDS

An important phase of the conservation program in any watershed is to preserve existing ponds and if possible to supplement these with new ones wherever the topography is suitable and the cost is within the scope of the purposes to be served. Such additional ponds in some cases can be made by rebuilding small mill dams which have been abandoned; by repairing existing dams; and by building new ones on suitable sites.

With the above purposes in mind, an inventory was made under the heading of community ponds on the Thames Watershed, in which the following information was assembled:

First, the location and condition, present and possible future use of small natural lakes or ponds;

Second, existing mill ponds which might be improved or used more extensively for community purposes;

Third, locations on streams where small ponds might be built by using old mill damsites or other places on small tributaries.

With the first two groups above, the report and the map which accompanies it give the location and condition, and in some cases recommendations regarding these; but the third group must be considered as a suggested program which can be acted upon at the present and enlarged in the future when funds are available.

There are hundreds of suitable sites for small ponds on the tributaries of the Thames, but keeping in mind that this report in only intended as a start in this work, a limited number of sites have been chosen. The object in making the selection is to distribute a pond-building program over the whole area.

Ponds have been classified as natural ponds (N), existing mill ponds (E) and possible ponds (P), which include former damsites capable of reconstruction. They are listed under townships.

Logan Township

1 (E) In Logan, the mill pond at Mitchell is still in, and is used to some extent for recreation. A new swimming pool and park supply most of the recreational need of the community.

2 (P) A possible site lies in Lot 15, Con. VII, at the hamlet of Willow Grove, but lack of trees and clayey banks make it not very suitable. It would require a dam approximately 300 feet long and 12 feet high to provide a pond of about 10 acres.

Ellice Township

3 (P) Ellice Township is almost completely drained artificially. A small pond might be possible on the upper part of Whirl Creek in Lot 30, Con. IX, with the orchard of an abandoned farm providing picnic grounds. The dam 250 feet long and 10 feet high would give a pond of 3-4 acres.

Easthope North Township

4 (E) The artificial lakes in the City of Stratford, covering about 20 acres, are used for boating and a limited amount of fishing.

5 (N) Lot 37, Con. I. Three kettle ponds about three miles east of Stratford. These have extents of 9, 5 and 3 acres respectively and have the usual marshy shorelines. They are, however, very conveniently located from Stratford and nearby sand pits might make the construction of small beaches practicable. The shores are well treed for shade.

Easthope South Township

6 (N) Lot 39, Con. I. Kettle pond of 13 acres, half a mile south of above. Same description applies.

7 (P) Lot 43, Con. VII. A small pond might be constructed here on Trout Creek, a dam 10 feet high and 200 feet long at the townline road making a pond of 3-4 acres. Better sites are available down stream in Downie Township.

33 (P) Lot 18, Con. IV, Sebastopol. No trace of former dam, but one could be built along the road between Cons. IV and V. The stream channel above the road has been dredged and straightened.

Downie Township

8 (P) Lot 19, Con. XII, Avon River. Pond of from 15-20 acres possible with dam 400 feet long, 20 feet high, on the road between Cons. XII and XIII. Good trees along bank and gravel bottom in stream.

9 (P) Lot 8, Con XIV, Otter Creek. Smaller pond possible here, with dam 300 feet long, 10 feet high. Banks are pasture with hawthorn and scattered trees. Bed of stream clean gravel.

34 (P) Lot 13, Con. VI, Avon River, Avonton. No trace of old dam but good site about ¼ mile above road for dam about 400 feet long and 12 feet high, to make a pond about ½ mile long.

Fullarton Township

10 (E) Lot 5, Con. VII. 15-acre mill pond at Carlingford. Good pond but little shade except near head of pond. Centrally located from Mitchell, St. Marys and Stratford.

35 (P) Lot 20, Con. I, Whirl Creek. Possible site ¼ mile above the road between Lots 20 and 21. Dam about 400 feet long. Valley widens above through open bush. Channel has been "improved". Also in Fullarton Township there had been dams and mills on the main stream of the North Branch of the Thames at Fullarton, Motherwell and Glengowan (Blanshard Township).

Blanshard Township

11 (P) Lot 31, Con.XII, Fish Creek, at confluence with North Branch of Thames. Good picnic spot in pasture with scattered trees, convenient to St. Marys. Removable dam on permanent sill across stream channel would give good small swimming pool.

12 (E) Quarry in St. Marys. Small abandoned quarry in south end of town, used as swimming pool.

36 (P) Lot 13, Con. II, Flat Creek. Anderson. The old dam has disappeared but a possible site lies 1,000 feet above the road.

52 (E) Con. XVII, Town of St. Marys. Large mill pond on North Branch of Thames at confluence of Trout Creek. Used for limited boating and fishing.

Zorra East Township

13 (E) Lot 8, Con. XVII. Quarry at Innerkip. The quarry has a water area of 14 acres up to 20-25 feet deep, spring-fed with clear cool water, and provides excellent swimming facilities convenient to Woodstock. Intermittent working is done but the north and west sides are not used for quarrying and would provide picnic sites.

14 (N) Lot 33, Con. XIV. 2 miles east of Tavistock. 4-acre kettle pond behind farmhouse. Small treed area with access to north shore of pond.

37 (P) Lot 18, Con. XI, Strathallan. No trace of old mill, but good site exists 100 yards above No. 19 Highway, with good access to Stratford and Woodstock.

38 (P) Lot 4, Con. XI. 5-acre pond. Central 100 feet and spillway of dam washed out. On property of Ontario Epileptic Hospital.

Zorra West Township

15 (P) Lot 30, Con. II. Duncan Pond, Harrington West. Spillway of the dam was blasted out after undermining by floods in 1948. The pond was about 20 acres and the clear cold spring water produced good trout, and maintained constant flow throughout the summer.

16 (P) Lot 28, Con. I. Branch of Trout Creek. A dam is being constructed (fall, 1951) to form a 14-acre private trout pond.

17 (P) Lot 31, Con. III. Branch of Trout Creek. The new owner of this property plans to re-establish the pond for his own use.

18 (E) Lot 13, Con. V. North Branch Creek. Upper Embro millpond. About 20 acres. Best access to pond by south side, pasture with scattered trees. Shore somewhat muddy.

39 (P) Lot 25, Con. V, Brooksdale. The old mill has disappeared. A possible site exists ¼ mile downstream from the sideroad for a shallow pond of 4-5 acres.

50 (P) Lot 12, Con. V.

51 (P) Lot 9, Con. V. Two mill ponds in the Village of Embro. Both dams require complete reconstruction to re-establish the 20-acre ponds.

Nissouri East Township

19 (N) Lot 24, Cons. XII and XIII. Mud Lake. Approximately 65 acres. Good access and shade along south shore for picnics. Shores are muddy, but rafts could be used for swimming.

A smaller pond, ½ mile east, is too marshy and difficult of access to be suitable.

20 (E) Lots 1, 2, 3, Con. X. Thamesford Mill pond. Extent 25 acres. Convenient access from London and Woodstock. Fair picnic facilities, but shores marshy. Mill in operation.

40 (P) Lot 19, Con. VIII, Waubuno Creek. No trace of old mill or dam. Possible site for low (10-foot) dam 300 feet long, 1,500 feet above Townline Road. Valley well treed above this point.

43 (P) Lot 16, Con. X, Kintore. 20-acre pond 1,000 feet above village. 150 feet of centre portion of dam, including spillway, require rebuilding.

Nissouri West Township

21 (P) Few pond sites exist, but the recreational needs of the township should be met by the facilities provided in the Thames Valley Park above the Fanshawe Dam.

41 (P) Lot 16, Con. III, Wye Creek, Thorndale. Possible site at cheese factory 1,000 feet above sideroad. Good pond of 15-20 acres from dam 400 feet long, 15 feet high.

42 (P) Lot II, Con. II, Wye Creek, Wyton. This old mill site will be drowned by the lake above Fanshawe Dam.

London Township

21 (P) Thames Valley Park also serves London Township.

22 (E) Lot 16, Con. VII. Arva Mill Pond: Large mill pond, 30 acres, on No. 7 Highway from London. Good picnic facilities. Shore muddy. South side best for development.

Dereham Township

23 (N) Lot 26, Con. III. Kettle pond. All stream drainage in this township is improved, and the only pond is this 5-acre kettle pond. It is difficult of access and the shores are very marshy.

Oxford East Township

24 (E) Lot 20, Con. IV, Cedar Creek. Large, 18-acre mill pond 4 miles south of Woodstock. Good access from Woodstock, and west side gives good picnic facilities. Dam is in good condition and mill operating.

25 (E) Small ornamental lake in park in Woodstock. Could be used for pleasure boating on a limited scale.

Oxford West Township

26 (P) Lot 13, Con. II. 3 miles east of Ingersoll. Old pond site requiring reconstruction of about 50 feet of dam 15 feet high, to provide a pond of some 10 acres. Good picnic site below dam.

27 (E) Lot 15, B.F. Con. 2 miles east of Ingersoll. Small, 3-acre pond having very well shaded shores. Good access from road on east side and convenient to Ingersoll. Good water for swimming.

44 (E) Lot 15, Con. I. Very small, 2-acre pond. Upper end marshy, but good banks at dam. Possible picnic sites below dam.

45 (P) Lot 5, Con. IV, Sweaburg. The original dam has disappeared and the stream channel completely dredged.

Oxford North Township

46 (P) Lot 20-21, Con. II, Middle Thames. Good damsite at road for 20-acre pond, with dam 400 feet long and 12 feet high. Large spring run-off.

Dorchester North Township

28 (E) Mill pond across Thames from Dorchester Station. Excellent recreational pond with good access by road along west side. The pond has an extent of about 30 acres and is 3/4 of a mile long. Banks and surroundings are well treed, and the whole pond area is suitable for recreational development.

29 (N) Lot 23, Con. II. Foster Pond. Two kettle ponds of approximately 11 and 5 acres. Shores are partly marshy but the north sides of each would provide suitable facilities.

47 (P) Lot 4, Thames Con., Putman. Washed-out millsite. Two short dams along road would restore former pond of about 15 acres.

Westminster Township

30 (N) Lots 18-19, Cons. I-II. 3 miles south of London. Two kettle ponds conveniently located from London, level controlled by dam at outlet. The larger has the shore fairly completely developed but the south and east sides of the smaller are suitable for recreation sites and have a clean shore, well treed.

31 (N) Lots 20-24, Con. I. Walker Ponds. These are three kettle ponds 2 miles south of London, similar to the above but located on Federal property.

48 (P) Lot 15, Con. III, Dingman Creek, Wilton Grove. The old dam here has disappeared and the stream channel has been dredged. There is a small kettle pond with marshy wooded shores in Lot 12, Con. IV.

Delaware Township

32 (P) W. of Lot 3, Con. I. Dingman Creek at Thames River. Old dam washed out, needs complete reconstruction, but would provide good pond and excellent recreational area in well-shaded surroundings. At village of Delaware, with good access from London.

Lobo Township

49 (P) Lot 14, Con. III, Oxbon Creek, Melrose. The original mill dam has disappeared but there are several places along about a mile of the stream where small dams 300 - 350 feet long would form good small ponds.

COMMUNITY PONDS

-LEGEND-

NATURAL PONDS (N)

EXISTING PONDS (E)

POSSIBLE PONDS (P)

SCALE 1 0 1 2 3 4 5 MILES

FIG H-30

WILDLIFE

CHAPTER 1

INTRODUCTION

There are three main objectives in conserving wildlife. The first is to retain for the citizens of this province the opportunity to fish and hunt, within the law, in an attractive environment, and where possible to trap fur for profit. The second is to retain for every citizen the opportunity to see and enjoy the varied forms of birds, mammals and other wildlife of any region in the greatest possible variety. The third objective is the maintenance of a natural balance between the numbers of the various species. A hawk which preys on destructive meadow mice in an orchard may be worth many dollars to the farmer who protects it.

Land well adapted for wildlife should therefore produce or harbour a permanent population of interesting and useful species and an annual crop of game and fur. These populations should be adapted in agricultural land so that they have no adverse effect on all reasonable farming practices. The control of harmful species and the maintenance of all other animal populations at a desirable level through the provision of a proper habitat, or living quarters, is a natural branch of good land management. The traditional methods of wildlife management have included restrictions of the daily and seasonal kill and of the method of kill, predator control, reservations of game lands and artificial restocking. The provision of a proper habitat is often more important than all of these. In Southern Ontario, and in particular in the Thames Watershed, the amount of good habitat available appears to be the controlling factor in the abundance of most wildlife. The two chief requirements for wildlife planning in this area are therefore a study of the existing habitat and a study of the wildlife populations, particularly the dynamics or changes of populations over a period of several seasons. The second requirement cannot possibly be carried out in a rapid survey.

The fieldwork was therefore concentrated on a few of the more significant problems. The watershed provides a great variety of wildlife habitat, and the streams vary widely in suitability for fish. A beginning has only recently been made in the basic research on game environments in Southern Ontario. The techniques of stream and lake survey are at present farther advanced. In the present survey the chief detailed work was therefore a study of the environment for fish. Of all other wildlife only one species was chosen for detailed attention. This species, the European hare, is potentially harmful to reforested areas and to orchards. It is also the most important game animal of Southern Ontario.

CHAPTER 2

FORMER SPECIES

The animals found in the Thames Watershed are a mixture of northern and southern species, with ranges which overlap in this area from two of the major life zones of North America. The overlapping ranges, in the watershed, of the pine mouse and Yellow-breasted Chat, more southern species, and the varying hare and White-throated Sparrow, more northern species, are typical examples of the transitional character of the fauna.

The country probably supported a maximum of game and the larger forms of wildlife a few years after it was first settled. The great variety of open and ungrazed woods, cleared fields and forest edges provided food and shelter for large populations. The cutting, burning and grazing of much of the remaining forest and intensive hunting and trapping have since then greatly reduced the wildlife populations.

In early times the wildlife was not always considered an asset. As early as 1796 David Zeisberger[1] wrote: "Raccoons, squirrels, bears, wolves and wild turkeys came in great numbers and did great harm to the fields". This record, written on the Thames River somewhat west of the watershed, is probably typical of the settlers' reaction to the wildlife.

Edward Allen Talbot[2], writing in 1824, referring to the District of London, lists 25 of the larger mammal species occurring in the district. Of these, 9 at

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1. Zeisberger, David. Diary of a Missionary to the Moravians, Vol. 11.

2. Talbot, Edward Allen. Five Years Residence in Canada. London. 1824.

least no longer occur in the watershed. They include the "catamount" (Felis couguar, now known as the cougar, which must have been at the extreme northern limit of its range) and the wolverine. Of the black squirrel Talbot reported: "He and his aide-de-camp, the red and striped squirrels, are the cause of more injury to the farmer than are all the other animals in America together, the wolf alone excepted". There were upwards of one thousand acres of corn destroyed by the squirrels alone within the Township of London in the summer of 1820. He also refers to the many large communities of beaver in the district.

William Pope[1], writing in 1834 concerning the London Area, also refers to the squirrel:

> "These animals do an immense deal of damage. I have seen a field of corn this season in which it was not possible to find a single head, the squirrels and raccoons having carried it all away. Nor must the woodpeckers be forgotten, as these birds are very mischievous among the corn. However, I would pass over the damage these birds do, in recollection of the immense benefits they confer at other seasons of the year in destroying vast quantities of insects".

Pope was an astute observer of natural history far ahead of his contemporaries.

Anna Jameson[2], writing of the cleared London Area in the 1830's, refers to it as "the haunt of the rattlesnake", also records the panther, and mentions the "Cock of the North" (the Pileated Woodpecker) as a common bird in those days.

Verschoyle Cronyn described the conditions on the Thames in the period 1830-1840:

> "Sleigh loads of deer for one dollar per carcass was a common thing. Wild turkeys, quail, partridge and pigeons abounded within the present limits of the City of London. The flight of wild pigeons in the spring of the year would at times almost

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1. Pope, William. Diary (unpublished manuscript). 1834.

2. Jameson, Anna. Sketches in Canada and Rambles among the Redmen. Longmans Green, London. 1852.

darken the sky; a belt of them, for hours at a time, extending from horizon to horizon. With the spring run of fish in the river, tons would be taken with seines and dip-nets, mostly suckers, but many mullet[1], bass, pike and occasionally sturgeon and maskinonje (lunges)".[2]

By 1846 the wildlife population of the watershed was rapidly changing. Smith[3] in that year records:

> "The living denizens of the forest are various, but their numbers are fast diminishing before the destructive progress of civilization".

> "Previous to the winter of 1842 wild turkeys were plentiful in the Western and London Districts; but the severity of that winter and the great depth of snow caused them to be completely starved out of the woods, and immense numbers were killed in the farmyards whither they had ventured in search of food. In consequence of the wholesale destruction not a single turkey was met with during the following year".

The turkey did appear again later in the watershed, but in fewer numbers. This species requires a habitat of dense cover and was doomed to extinction in this district at the limit of its northern range. The last birds heard of in the watershed were near Arva in 1885[4]. It is interesting to note that already (by 1846) the decline in some species of game and fish had been observed and discussed in Government circles, and a bill had been passed making a closed season for most game from the 10th of May to the 15th of August, and prohibiting the trapping and snaring of grouse and quail. This bill had little effect.

The watershed lay close to the centre of the breeding range of the Passenger Pigeon. Mitchell[5] cites numerous records of large and small colonies breeding in Oxford, Perth and Middlesex Counties. The pigeon was notable

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1. Probably referred to the northern redhorse sucker as distinct from the common white sucker already mentioned.

2. Cronyn, Verschoyle, "The First Bishop of Huron". Transactions of the London and Middlesex Historical Society, Part III. 1911.

3. Smith, W. H. Smith's Canadian Gazetteer. Toronto. 1846.

4. Saunders, W.E. Birds of Middlesex County.

5. Mitchell, Margaret H. The Passenger Pigeon in Ontario. Royal Ontario Museum of Zoology Publication. 1935.

Snake fences and weedy patches, such as this, are now uncommon in many parts of the watershed. They provided cover and food for the Bobwhite and Ring-necked Pheasant.

Clean fences are now considered by most farmers to be one of the hallmarks of good farming practices. They provide no cover for game. Substitutes such as wild life food and cover plots should therefore be included in planning for game management.

for its great beauty, its gregarious habit, its vast flocks and its amazing extinction in the face of the clearing of land and the market shooting and trapping of the late nineteenth century. Apparently, the birds began to decrease imperceptibly in the 17th century in settled North America, but were still present in vast numbers about 1860, declining slowly until 1880 and more rapidly thereafter. The last authentic breeding record in the watershed was made in 1885, but the birds probably persisted in small numbers for about ten years more. Two were seen at Walker's Pond near London in 1892[1].

The Bobwhite Quail probably reached its maximum density at the beginning of this century. For this bird the old snake fences and weedy patches, the frequent orchards and winter corn, and the high dry fields and open oak and maple woods made a perfect habitat. This kind of habitat was rapidly reduced. At the same time the birds were fetching fifteen to twenty cents a pair when sold to the local hotels. The shooting season lasted three months. The result was inevitable. By 1930 very few birds remained. A covey was seen in the watershed in 1938 and a few single birds have been reported since then.

The wapiti or American elk, the handsomest of all the deer family, formerly roamed in and around the watershed, antlers having been found in Norfolk County to the south-east[2] and a skeleton located in a swamp in Lobo Township[3], Middlesex County. The wapiti may have become extinct in Southern Ontario before the Thames Watershed was settled.

The white-tailed deer was a common species at the time of settlement and became even more abundant when a

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1. Record of Edward Dutton of Woodstock.

2. Dymond, J. R. The Wapiti in Ontario. Canadian Field Naturalist, Vol. XV. 1926.

3. Smith, L. H. Ottawa Naturalist, Vol. XV. July 1901.

small part of the land was cleared, doing some damage to the crops.

Deer disappeared from the watershed through hunting pressure some fifty years ago, holding out only until about 1910 in the Canada Company's land at the north-west corner of the watershed[1]. By 1925 they were again found in the watershed, and they are now common.

The following are the chief species of wildlife which were present in the watershed at the time of early white settlement, but are no longer to be found in the area. The list is based on the available literature of the time. For those species marked with an asterisk there is no actual record but the watershed was well within their primitive range.

Mammals

Beaver	*Castor canadensis* (Kuhl)
Black Bear	*Ursus americanus* Pallas
Marten	*Martes americanus* (Turton)
Fisher	*Martes pennanti* (Erxleben)
Wolverine *	*Gulo luscus* (Linnaeus)
Timber Wolf	*Canis Lupus* Linnaeus
Otter	*Lutra canadensis* (Schreber)
Bay Lynx *	*Lynx rufus* (Schreber)
Canada Lynx	*Lynx canadensis* Kerr
Cougar	*Felis couguar* Kerr

Birds

Wild Turkey
Passenger Pigeon

Of the above species, the otter, Bay lynx, and timber wolf may still occur rarely.

1. Saunders, W.E. Notes on the Mammals of Ontario. Transactions of the Royal Canadian Institute 1932.

CHAPTER 3

PRESENT SPECIES

There is a rapidly growing interest in natural history in Ontario. Both London and Woodstock have a long history of activity in this direction. Lists are here included of the species of mammals and birds, amphibians and reptiles that may be encountered in the watershed.

The watershed now provides a breeding habitat for at least 123 species of birds, 38 species of mammals, 15 species of amphibians and 14 species of reptiles. In addition some 134 species of birds migrate through or visit the watershed but do not breed in it. The figures for breeding species of birds are somewhat low compared with many areas of similar size in Southern Ontario because the watershed has few lakes and most of it is intensively cultivated.

The lists are extracted from more detailed information and records of the late W. E. Saunders and E. M. S. Dale[1], J. Dewey Soper, Herbert Milnes of Woodstock and Stuart Downing of the Royal Ontario Museum of Zoology.

1. Mammals

The arrangement and terminology of the list follow those in "A Provisional Check List of the Mammals of Ontario" by S. C. Downing (Misc. Publication #2, Royal Ontario Museum of Zoology, Toronto, 1948).

Cinereous Shrew	Sorex cinereus Kerr	C
Smoky Shrew	Sorex fumeus Miller	R
Pigmy Shrew	Microsorex hoyi (Baird)	R
Mole Shrew	Blarina brevicauda (Say)	C
Hairy-tailed Mole	Parascalops breweri (Bachman)	R
Star-nosed Mole	Condylura cristata (Linnaeus)	C
Little Brown Bat	Myotis lucifugus (LeConte)	A
Long-eared Brown Bat	Myotis keenii (Merriam)	R
Silver-haired Bat	Lasionycteris noctivagans (LeConte)	R
Big Brown Bat	Eptesicus fuscus (Beauvois)	C
Red Bat	Lasiurus borealis (Müller)	R

1. Saunders, W. E., and Dale, E. M. S. A History and List of the Birds of Middlesex County, Ontario, Transactions of the Royal Canadian Institute, Vol. XIX, Part 2. Sept. 1933.

Hoary Bat	Lasiurus cinereus (Beauvois)	R
European Hare	Lepus europaeus Pallas	A
Varying Hare or Snowshoe Rabbit	Lepus americanus (Allen)	R
Cottontail	Sylvilagus floridanus (Allen)	C
Black Squirrel	Sciurus carolinensis Gmelin	A
Red Squirrel	Tamiasciurus hudsonicus (Erxleben)	C
Woodchuck	Marmota monax (Linnaeus)	A
Eastern Chipmunk	Tamias striatus (Linnaeus)	C
Eastern Flying Squirrel	Glaucomys volans (Linnaeus)	C
Northern Flying Squirrel	Glaucomys sabrinus (Shaw)	R
Deer Mouse	Peromyscus maniculatus (Wagner)	C
White-footed Mouse	Peromyscus leucopus (Rafinesque)	C
Cooper's Lemming Mouse	Synaptomys cooperi Baird	R
Muskrat	Ondatra zibethica (Linnaeus)	C
Meadow Mouse	Microtus pennsylvanicus (Ord)	C
House-Rat	Rattus norvegicus (Erxleben)	A
House Mouse	Mus musculus Linnaeus	A
Meadow Jumping Mouse	Zapus hudsonius (Zimmermann)	C
Porcupine	Erethizon dorsatum (Linnaeus)	R
Brush Wolf	Canis latrans Say	R
Red Fox	Vulpes fulva (Desmarest)	A
Raccoon	Procyon lotor (Linnaeus)	A
Ermine	Mustela erminea Linnaeus	C
Long-tailed Weasel	Mustela frenata Lichtenstein	C
Mink	Mustela vison Schreber	C
Skunk	Mephitis mephitis (Schreber)	A
White-tailed Deer	Odocoileus virginianus (Boddaert)	C

A - Abundant; C - Common; R - Rare

2. Birds

(The arrangement and the names are from L.L. Snyder's 'Ontario Birds', 1951.) The common birds of the watershed are listed as Permanent Residents, Summer Residents, Migrants and Winter Visitors. An additional list of Rare Birds includes those which are occasionally seen.

Key: OW - Occasional Winter Visitor
SV - Summer Visitor
A - Accidental Records, and very rare stragglers
RN - Rarely nests

Permanent Residents (Nesting and Wintering)

Ruffed Grouse
Common Pheasant
Rock Dove
Horned Owl
Long-eared Owl
Short-eared Owl
Pileated Woodpecker
Hairy Woodpecker
Downy Woodpecker
Blue Jay
Crow
Black-capped Chickadee
White-breasted Nuthatch
Brown Creeper
Winter Wren
Cedar Waxwing
Starling
House Sparrow
Cardinal
American Goldfinch
Slate-colored Junco

Summer Residents

Pied-billed Grebe
Great Blue Heron
Green Heron
American Bittern
Least Bittern
Mallard
Black Duck
Blue-winged Teal
Wood Duck
Turkey Vulture
Sharp-shinned Hawk
Cooper's Hawk
Red-tailed Hawk
Bald Eagle
Marsh Hawk
Sparrow Hawk
Virginia Rail
Sora
Killdeer
American Woodcock
Upland Plover
Spotted Sandpiper
Herring Gull
Mourning Dove
Yellow-billed Cuckoo
Black-billed Cuckoo
Screech Owl
Whip-poor-will
Nighthawk
Chimney Swift
Ruby-throated Hummingbird
Belted Kingfisher
Yellow-shafted Flicker
Red-headed Woodpecker
Yellow-bellied Sapsucker
Eastern Kingbird
Crested Flycatcher
Eastern Phoebe
Traill's Flycatcher
Least Flycatcher
Eastern Wood Pewee
Horned Lark
Tree Swallow
Bank Swallow
Rough-winged Swallow
Barn Swallow
Cliff Swallow
Purple Martin
House Wren
Marsh Wren
Sedge Wren
Catbird
Brown Thrasher
Robin
Wood Thrush
Veery
Bluebird
Loggerhead Shrike
Yellow-throated Vireo
Warbling Vireo
Black and White Warbler
Golden-winged Warbler
Yellow Warbler
Black-throated Green Warbler
Blackburnian Warbler
Cerulean Warbler
Chestnut-sided Warbler
Pine Warbler
Oven-bird
Water-thrush
Mourning Warbler
Maryland Yellow-throat
American Redstart
Bobolink
Eastern Meadowlark
Red-wing
Baltimore Oriole
Grackle
Cowbird
Scarlet Tanager
Rose-breasted Grosbeak
Indigo Bunting
Purple Finch
Towhee
Savannah Sparrow
Grasshopper Sparrow
Vesper Sparrow
Chipping Sparrow
Field Sparrow
Swamp Sparrow
Song Sparrow

Migrants

Common Loon
Horned Grebe
Whistling Swan
Canada Goose
Gadwall
Pintail
Green-winged Teal
Baldpate
Shoveller
Redhead
Ring-necked Duck
Canvas-back
Greater Scaup
Lesser Scaup
Buffle-head
Ruddy Duck
Hooded Merganser
Red-breasted Merganser
Broad-winged Hawk
Rough-legged Hawk
American Coot
Ringed Plover
Common Snipe
Solitary Sandpiper
Greater Yellow-legs
Lesser Yellow-legs
Pectoral Sandpiper
Least Sandpiper
Dunlin
Semipalmated Sandpiper

Olive-sided Flycatcher
Red-breasted Nuthatch
Hermit Thrush
Swainson's Thrush
Golden-crowned Kinglet
Ruby-crowned Kinglet
Water Pipit
Solitary Vireo
Philadelphia Vireo
Tennessee Warbler
Nashville Warbler
Parula Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Myrtle Warbler
Blackburnian Warbler
Bay-breasted Warbler
Black-poll Warbler
Palm Warbler
Wilson's Warbler
Rusty Blackbird
White-crowned Sparrow
White-throated Sparrow
Fox Sparrow

Winter Visitors

Common Golden-eye
Old Squaw
Common Merganser
Snowy Owl
Great Shrike
Redpoll
Pine Siskin
Tree Sparrow
Snow Bunting

Rare Birds (including accidental records)

Red-throated Loon
Red-necked Grebe
Double-crested Cormorant
Egret
Little Blue Heron
Night Heron
Snow Goose
Blue Goose
King Eider
White-winged Scoter
Surf Scoter
Black Scoter
Goshawk
Golden Eagle
Gyrfalcon
Peregrine Falcon
Pigeon Hawk
King Rail
Yellow Rail
Gallinule
Golden Plover
Black-bellied Plover
Turnstone
Whimbrel
White-rumped Sandpiper
Baird's Sandpiper
Dowitcher
Stilt Sandpiper
Sanderling
Red Phalarope
Northern Phalarope
Glaucous Gull
Ring-billed Gull
Bonaparte's Gull
Common Tern
Caspian Tern
Black Tern
Thick-billed Murre
Barn Owl
Barred Owl
Great Gray Owl
Tengmalm's Owl
Saw-whet Owl
Red-bellied Woodpecker
Arctic Three-toed Woodpecker
Common Three-toed Woodpecker
Canada Jay
Raven
Boreal Chickadee
Tufted Titmouse
Bewick's Wren
Carolina Wren
Mockingbird
Gray-cheeked Thrush
Blue-gray Gnatcatcher
Greater Waxwing
Prothonotary Warbler
Worm-eating Warbler
Blue-winged Warbler
Orange-crowned Warbler
Kirtland's Warbler
Prairie Warbler
Louisiana Warbler
Kentucky Warbler
Connecticut Warbler
Yellow-breasted Chat
Hooded Warbler
Orchard Oriole
Dickcissel
Evening Grosbeak
Pine Grosbeak
Crossbill
White-winged Crossbill
Henslow's Sparrow
Lark Sparrow
Clay-colored Sparrow
Harris' Sparrow
Lincoln's Sparrow
Lapland Longspur

3. <u>Amphibians and Reptiles</u>

The watershed is not within the known range of any venomous snakes. It is unlikely that any rattlesnake would ever be found in the area. It should be added that neither copperheads nor water moccasins occur in Ontario at all and the common water snake is not venomous.

All the following species have been recorded in the watershed:

Mudpuppy	*Necturus maculosus*[1] (Rafinesque)	C
Newt	*Triturus viridescens* (Rafinesque)	C
Jesserson's Salamander	*Ambystoma jeffersonianum* (Green)	C
Spotted Salamander	*Ambystoma maculatum* (Shaw)	R
Four-toed Salamander	*Hemidactylium scutatum* (Schlegel)	R
Red-backed Salamander	*Plethodon cinereus* (Green)	A
Common Toad	*Bufo americanus* (Holbrook)	A
Swamp Tree Frog	*Pseudacris triseriata* (Wied)	C
Pickering's Hyla	*Hyla crucifer* (Wied)	C
Common Tree Frog	*Hyla versicolor* (Le Conte)	C
Bullfrog	*Rana catesbeiana* (Shaw)	C
Green Frog	*Rana clamitans* (Latreille)	C
Leopard Frog	*Rana pipiens* (Schreber)	A
Pickerel Frog	*Rana palustris* (Le Conte)	C
Wood Frog	*Rana sylvatica* (Le Conte)	C
Hog-nosed Snake	*Heterodon contortrix* (Linne)	R
Smooth Green Snake	*Opheodrys vernalis* (Harlan)	C
Milk Snake	Lampropeltis t. triangulum (Lacépède)	C
Queen Snake	*Natrix septemvittata* (Say)	R
Water Snake	*Natrix s. sipedon* (Linne)	R
Brown Snake	*Storeria dekayi* (Holbrook)	R
Red-bellied Snake	*Storeria occipitomaculata* (Storer)	R
Ribbon Snake	*Thamnophis s. sauritus* (Linne)	R
Garter Snake	Thamnophis s. sirtalis (Linne)	A
Snapping Turtle	*Chelydra serpentina* (Linne)	C
Spotted Turtle	*Clemmys guttata* (Schneider)	R
Blanding's Turtle	*Emys blandingii* (Holbrook)	R
Western Painted Turtle	*Chrysemys belli marginata* (Agassiz)	A
Soft-shelled Turtle	*Amydra spinifera* (Le Sueur)	R[2]

R - Rare; C - Common; A - Abundant

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1. The species named follow those of "The Reptiles of Ontario" by E. B. S. Logier (Royal Ontario Museum of Zoology Handbook No. 4, 1939).

2. Based on one specimen taken at Beachville, Oxford County.

CHAPTER 4

IMPROVING THE FARM FOR WILDLIFE

Recommendations for specific improvements for individual farms on the Thames Watershed would involve detailed examination beyond the scope of the present survey. Moreover the requirements such as cover and food vary greatly for different species. On the Thames Watershed the existing conditions are also widely divergent. In the Townships of Ellice and Logan, for instance, much of the land is flat and open with bare fences, dry stream beds and cover reduced to overgrazed elm - soft maple woodlots. In the hilly areas in and surrounding Zorra West Township there are many wooded valleys and good cover is comparatively common. There are also such varied habitats as the Ellice Swamp and the tobacco plantations on sand in Dorchester Township. Between these extremes there are many varied types of land. The recommendations here listed are therefore those which can be most generally applied by the landowner.

1. Woodlands

The elimination of grazing of woodlots would be the most useful single measure in improving the wildlife environment. Large-scale reforestation plans are included in the Forestry report. In plantations, up to about the tenth year from planting, the entire planted area is valuable for wildlife. But large blocks of coniferous trees will, at least after the twelfth year from planting, have little or no undergrowth and will, apart from their edges, be comparatively sterile as far as upland game and most forms of wildlife are concerned. The chief improvements to be expected will therefore come from good management of the farm woodlot. Selective cutting is both sound forestry practice and good planning for wildlife. Landowners who have woodlots in which the crown canopy has closed over considerable areas, and who wish to

produce a proper environment for wildlife, will find that release cuttings, slashings to stimulate sprout growth, thinnings and felling timber for sale will improve rather than retard the carrying capacity for wildlife. Construction of brush piles from cuttings is recommended where rabbits are desired, two or three such brush piles per acre being the normal spacing.

2. Cultivation Practices

All good farming practices which make a more luxuriant vegetation will improve the farm environment for wildlife. A few special practices will give more specific benefits. Strip-cropping, described elsewhere in this report, is of particular value since by this means no extensive area is denuded of cover at one time by harvesting. In the less flat parts of the watershed, filter strips, either above water-diversion terraces or used as emergency waterways, provide travel lanes and nesting cover for wildlife. Cover crops such as the clovers provide a habitat and food for wildlife in areas that would otherwise be barren during the winter months.

The elimination of brushy fencerows is now the rule rather than the exception on Southern Ontario farms. Those who are interested in wildlife improvement will find that the inclusion of a few field boundary hedges on the farm will moderate the effect of winds on crops, serve as travel lanes and cover for wildlife, and harbour large numbers of songbirds which help to control insect pests. Inevitably the presence of boundary hedges on a farm tends to encourage the growth of weeds. This is the price that must be paid for improved wildlife conditions. *Rosa multiflora* is an excellent hedge-forming shrub. It has a tendency in Southern Ontario to die back in winter, but rapidly forms a dense hedge, which is reported to be proof against cattle and hogs. It provides both cover and food and does not exhaust the nearby cultivated ground.

CONTROL OF HUNTING

3. Food and Cover Patches

Field corners are frequently barren of crops. Therefore a fence crossing which embraces the corners of four fields may be made into a haven for ground-nesting species by planting a few trees and shrubs and protecting them. It is important to rid such areas of useless weeds by crowding them out with useful species such as white sweet clover or the normal climax type of open vegetation which is bluegrass.

There are still several groups of sportsmen who would like to see pheasants permanently established in this part of Southern Ontario, and pheasants are frequently released in the watershed. An investigation of the status of pheasants in Ontario, carried out by the Provincial Department of Lands and Forests, has shown that most of the Thames Watershed is unsuitable for the species. Even the more southerly part of the watershed provides only marginal pheasant territory. The average snowfall, 65 to 80 inches, is comparatively heavy for Southern Ontario, and the watershed is also more often subjected to sleet storms than most of the Province[1]. There is also a serious shortage of cover for pheasants in the northern half of the watershed. Periodic winter killing of most or all of the population may therefore be expected. A fair population was built up in some sections by 1944, but practically no birds survived the winter and spring of 1944-45 and the species is still uncommon. Pheasants which have to be fed at the barnyard can hardly be compared with ordinary wild game. Those who wish to farm the species should provide food patches to supplement the available diet of scattered ragweed and other low plants. Short rows of standing corn or corn in shocks should be left close to good cover. Buckwheat, soybeans and Japanese millet are also recommended. Disused and loose rolls of fence wire left at the edges of woodlands provide useful

1. Clarke, G. H. D., and R. D. Brafette. Ringnecked Pheasant Investigations in Ontario 1946. Department of Lands and Forests, Ontario.

additional cover. Any gullied area in which groups of evergreen trees are planted for erosion control is also of value to wildlife.

4. Ponds and Streams

The importance of water to wildlife is often forgotten. Many farms have at least one low spot where a small amount of work with a scoop will provide a dam and a pond to provide nesting and feeding sites for water and marsh birds. If possible ponds for wildlife should be separate from those intended for cattle or for fish. Willow cuttings pushed in the ground around such a hollow will rapidly provide wildlife cover. New water areas will soon be invaded by aquatic plants, but additional species may have to be introduced. No extensive duck food studies have been made in Southern Ontario. Wild rice may be introduced, but since it is not well adapted to wide variations in water levels, being often sterile in fluctuating waters, it cannot be considered as certain to succeed. The idea has long been current, and is fostered by many sportsmen's organizations, that the planting of wild rice is the answer to the problem of how to attract ducks to any area. The fact is that wild rice is of little significance to ducks in Canada except in the fall, and does not provide good cover or nesting sites. The following species which may be easily obtained are recommended as certain to be valuable duck foods. If none of them occur in ponds or shallows with good cover for ducks they can be introduced.

Sago Pondweed	Potamogeton pectinatus L.
Red-Head Pondweed	Potamogeton Richardsonii (Ar. Benn.) Rybd.
Wild Millet	Echinochloa crusgalli (L) Beauv.
Japanese Millet	Echinochloa frumentacea (Roxb) Link
Wild Celery	Vallisneria americana Michx.
Knotweed	Polygonum pensylvanicum L.
Water-Smartweed	Polygonum coccineum Muhl.
Three-square	Scirpus americanus Pers.
Great Bulrush	Scirpus validus Vahl., var. creber Fern.

Those who are interested in farm ponds for wildlife will find very useful details of the various types of

This kettle pond, near Crystal Lake, at Concession XIII, Lot 25, in Nissouri East Township, is one of the few remaining ponds in the watershed where wild ducks nest undisturbed by man.

The pond at St. Marys provides small-mouth bass fishing.

The south branch of the Thames near Dorchester has a fair population of small-mouth bass, but is occasionally polluted by materials entering the river at Woodstock and Ingersoll.

pond and methods for constructing each type in the chapter on Farm Ponds in the Land Use section of this report. Farm ponds differ from those intended for wildlife in that care is usually taken to prevent the growth of aquatic vegetation in a farm pond intended only for watering stock or fire protection purposes. Otherwise the construction and details of ponds for wildlife should follow one of the types there described.

CHAPTER 5

SPECIES OF IMPORTANCE TO AGRICULTURE AND FORESTRY

1. The European Hare

(a) Introduction

The most important game animal on the Thames Watershed is the European hare (*Lepus europaeus Pallas*), which most people in Ontario know as the "Jackrabbit". The species was originally introduced from Germany. It was introduced several times into the eastern United States, but Ontario Jackrabbits are probably all derived from seven females and two males which escaped from captivity near Brantford in 1912. Dymond (1922)[1] has described the circumstances and early results of this addition to our fauna.

From this humble beginning the European hare increased its range and numbers enormously and soon came to occupy all the agricultural portions of Ontario south of a line extending roughly from the southern end of Georgian Bay through Peterborough to Kingston.

The exact dates of the Jackrabbit's arrival on the Thames Watershed have not been recorded, although from accounts by Dymond,[1,2,3] Saunders[4], Howitt[5] and Soper[6] it is apparent that the animal must have been well established in Middlesex County by 1920 or earlier.

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1. Dymond, J.R. The European Hare in Ontario. Canadian Field-Naturalist, 36(8): 142-143. 1922.

2. Dymond, J.R. The Present Range of the European Hare in Ontario. Canadian Field-Naturalist, 42(4): 95. 1928.

3. Dymond, J.R. The Spread of the European Hare in Ontario. Royal Ontario Museum of Zoology Bulletin 2:9-11. 1929.

4. Saunders, W.E. Notes on the Mammals of Ontario. Transactions of the Royal Canadian Institute, XVIII, Part 2: 271-309. 193

5. Howitt, Henry. Another Invasion of Canada. Canadian Field-Naturalist, 39(7): 158-160. 1925.

6. Soper, J. Dewey. The Mammals of Wellington and Waterloo Counties, Ontario. Journal of Mammalogy, 4:244-252. 1923.

(b) Habitat Preferences

Extensive open fields, pastures, croplands and scattered, heavily pastured woodlands are the home of the European hare at all seasons of the year. Much remains to be learned about the exact nature of the hare's habitat preferences and tolerances, but it appears that most of the farming country of the watershed is admirably suited to it.

Locally, as in areas where tobacco is the leading crop or where white cedar thickets or swampy areas abound, the hare is present only in small numbers, but these regions compose a small percentage of the watershed's area in the aggregate. The preponderance of extensive open fields devoted to mixed farming and dairying seem to be satisfactory hare range.

Many forms of game and other wildlife are more restricted numerically by a scarcity of suitable habitat than by any other single environmental factor, but on this watershed there seems to be ample range suited to maintaining a good population of Jackrabbits.

(c) Food

Jackrabbits are almost exclusively herbivorous, although there are a few well-authenticated reports of them eating flesh. On the Thames Watershed the green portions of almost all garden and farm crops are eaten when available, as well as a variety of bark, twigs, shoots and buds of woody plants.

In all seasons except winter the Jackrabbit hardly ever comes into competition with man's interests, since it feeds on a wide variety of plants and rarely concentrates on any particular crop sufficiently to do appreciable damage. It may be described as a "spotty" feeder. Thus it does not settle to feed in a small area and stay there until all the nearby plants are consumed; instead it wanders about nibbling here and there so that any damage is widely scattered.

In winter, especially if the snow is deep, there is comparatively little green vegetation available. The hare will then turn its attention to edible portions of fruit trees, trees in forest plantations and ornamental hedges. The damage which even a small number of these animals can inflict on such plantings can be severe.

(d) Status on the Watershed

Numerically, the European hare has had a varied existence on the Thames Watershed and in Ontario as a whole. In the course of its original range extension, following its introduction near Brantford in 1912, it spread all across the suitable parts of the watershed and soon became an important game animal. Dymond[1] wrote that "Roger Headley of Ilderton... says that up to February 7th, 1929, 300 of these hares had been killed in an area of six square miles during the past winter and that many more remained. Later he reported that on February 18th seven men hunting over an area of a little more than one square mile had killed 10 hares and seen 80 more." They appear to have been equally common in East Nissouri Township, Oxford County, about the same time.

They remained at about this level of population throughout the 1930's despite large numbers being killed by hunters. For one hunter, in a group of sportsmen engaged in a Jackrabbit "drive", to shoot a dozen of these animals in the course of an afternoon's hunting was not infrequent.

During the early 1940's this situation altered drastically. In a matter of a few years the hare became so scarce that many sportsmen's associations that had originally organized for the purpose of hunting it were forced to disband for lack of targets.

The hare could hardly have been expected to maintain its numbers indefinitely in the face of such hunting pressure, but Canada was at war during the years 1939 through 1945, and hunting pressure at this time was very much reduced.

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1. Dymond, J.R. The Spread of the European Hare in Ontario. Royal Ontario Museum of Zoology Bulletin 2:9-11. 1929.

Despite this hunting reduction the decline of hares in Ontario continued precipitately. Previously the hare held its own despite the high pressure.

In the course of studies of the Jackrabbit in adjacent areas of Ontario during the summer of 1948 it became apparent for the first time that its population in at least some parts of the Province was showing signs of increasing. This was confirmed the following winter when hunter successes were compared with those of recent years. The increase appears to be continuing on and adjacent to the Thames Watershed, although it is reported to be less apparent in more distant regions of the Province.

(e) Predation

The role of predation on the hare population is highly controversial. It has been demonstrated that in many populations of animals predation in itself is rarely of great importance in determining the size of the population. Many biologists hold that animals that fall to predators are merely escaping death by some other agency; predators take those animals which are unable to escape because of lack of places in which to hide, because they are weak or because they are sick.

Many hunters believe that a correlation may exist between the decline in numbers of Jackrabbits and an apparently coincident increase in the numbers of red foxes in many parts of Southern Ontario. The significance of this situation has not been investigated. The red fox is almost universally condemmed by hunters and many farmers on the watershed but this condemnation is based almost entirely on speculation, hearsay and fragmentary evidence. No adequate food-habits study of the red fox in Ontario has been made.

Other predators, such as Hawks and Owls, occur in variable numbers on the watershed, but these probably have little or no adverse effect on hare populations.

(f) Crop Damage

Since the Jackrabbit's food may include the bark, twigs and buds of orchard trees, the species is a potential menace to orchards in winters of heavy snows when other food is scarce. Here the conflicting interests of farmers (who want all hares destroyed) and hunters (who want more hares to hunt) come into sharp focus. The hare has also been known to damage forest plantations. Repellent sprays that could be applied to the trees provide the obvious answer to the problem. Such a spray must keep its repellent effect for months and must be efficient even in zero weather. Sprays of this nature have been developed in the laboratory but their applicability in field conditions has not been tested.

The position of the Jackrabbit in the watershed may be summarized as follows:

It is the most important game animal of the watershed, and most of the watershed provides conditions suitable for high hare populations. The species was well established on the watershed by 1929, provided much hunting for the following ten years, declined in the early 1940's, but is again on the increase. The effect of the red fox as a predator on Jackrabbit populations is not known. Research is required for the production of repellent sprays to protect fruit and other trees from this mammal.

2. The Meadow Mouse

(a) Status

The comparatively recent emphasis on the acquisition and reforestation of poorly drained land surrounding headwater swamps raises the problem of control of the meadow mouse. Many people are aware of the damage which the meadow mouse (*Microtus pennsylvanicus*) can inflict on young orchard trees. The species can also girdle and destroy young trees, both hardwood and softwood, in reforestation projects and nurseries.

One example should indicate the danger. In the winter of 1947-8 on a farm near Exeter, Huron County, 95 per cent of 26,000 trees in a 20-acre plantation of Scotch pine were girdled and killed in a few weeks by meadow mice. Similar devastation took place in a plantation in York County in 1944. Since considerable areas of the Thames Watershed are being recommended for reforestation, the possibility of meadow mouse damage cannot be ignored.

Indications of four-year cycles in the population of this species have been reported from New York State[1] and Ohio[2]. Records of the Royal Ontario Museum of Zoology show no signs of a widespread uniform population cycle in Ontario. It seems more probable that in Ontario at least the critical factor in population changes may vary in different years. It may be any one of a number of climatic factors such as the depth of snow, occurrence of freezing rain, or some other factor such as predator abundance, food supply and disease.

In any given year in Ontario the chances are small that a large population of meadow mice will be built up in the late summer and that they will continue to breed in the fall and survive until the grasses are no longer palatable and snow is deep on the ground. But when this does happen any plantation which is overrun will be decimated. There is no doubt that to reforest any area having a dense mat of tall grasses or sedges (the preferred range of the mice), without protecting it from mice by some means, is to invite disaster. Both idle, poorly drained (low-lying) sand lands and muck areas covered with willow scrub or similar vegetation can support large populations. Plantations on well drained sandy slopes are also vulnerable if they adjoin low areas of long grass and sedges.

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1. Hamilton, W.J. Field Mouse and Rabbit Control in New York Orchards. Cornell Extension Service Bulletin 338.

2. Bole, B.P. The Quadrat Method of Studying Small Mammal Populations. Science Publications of Cleveland Museum of Natural History No.4.

In September 1950 estimates were made of the relative abundance of meadow mice in areas of the watershed which were being considered for reforestation. The purpose of this work was both to assess the immediate vulnerability of areas that might be replanted, and to provide data for a wider study of Microtus populations in the Province.

The presence or absence of fresh runways was considered to be a satisfactory index of abundance. The whole of each tract could not be examined, but wherever possible the areas having the best Micrctus habitat in each tract were visited.

One hundred and fifty-eight areas were visited, varying in size from a few acres to several hundred. They were classified as follows:

No evidence of Microtus found	70
Microtus occurred locally	74
Microtus abundant locally	14

The areas were also classified according to their vulnerability to Microtus, based on the soil, vegetation and other cover in the areas or along their edges. The areas were grouped as follows:

Plots comparatively safe from Microtus damage	35
Plots vulnerable to Microtus	99
Plots very vulnerable to Microtus	24

Many of the areas were classified as vulnerable because they adjoined low land with dense vegetation providing excellent cover and food for meadow mice.

Of the 15 areas recommended (in the Forestry section of this report) for acquisition for reforestation, 4 were considered to be safe from Microtus damage. The remaining 12 were considered to be vulnerable, and 4 of these were classed as very vulnerable. Some notes concerning some of these follow. The numbering of the areas refers to the numbers on the Forestry map in this report.

The Blandford area (9) and the Avon River (4) are comparatively safe for replanting, as are the lighter soils on the edge of the Komoka Swamp (10) and much of the South Dorchester Swamp area (12).

The most vulnerable areas are the old pastures and willow scrub surrounding the Ellice Swamp, (1), the Gads Hill Swamp (2), the Golspie Swamp (8) and the Cedar Creek Swamp (15).

In the last-named area meadow mice were common everywhere except in the woodlands. The sections of the Trout Creek area (6), in Concessions III to VIII of Zorra West Township, are also very vulnerable to Microtus since much of this area consists of steep slopes rising from a valley floor which has excellent cover for Microtus. Several parts of the Moraine reforestation area (7) are also of this type.

All the remaining areas recommended for acquisition should be considered as vulnerable to meadow mice, since all include patches of dense grasses and sedges. Many of these are more vulnerable than they appear, since the elimination of grazing, after reforestation, will allow long grass to develop on some of the slopes.

(b) Control Measures

There are two alternative methods of eliminating damage to trees by rodents. The first is to kill the mice. The second is to protect the trees by repellents, wire guards or removal of all suitable cover.

Advice on the use of poisons against mice is available from the Research Division of the Department of Lands and Forests. Strychnined oats and pieces of apple treated with zinc phosphide are the most commonly used poisons. Recently a method of distributing cracked corn (poisoned with zinc phosphide), dropped from a hand garden seeder in long grass, has

been developed.[1] A green dye is added to the corn and is said to repel birds. There is inevitably some danger to wildlife from these methods. The bait is extremely toxic to pheasants and rabbits and the toxicity does not disappear for many weeks.

Sprayable poisons have not so far been found to be of practical use.

The importance of predators of the meadow mouse should not be overlooked. Microtus forms an important part of the diet of the larger snakes, all the hawks other than the accipiters, the common owls and the shrew, weasel, skunk, and fox. The only species of hawks in Ontario which take a high percentage of poultry and large game birds are the Goshawk, the Cooper's Hawk and occasionally the Marsh Hawk. Of these the Goshawk is rare even in migration. Although poultry farmers are probably justified in destroying the Cooper's Hawk and the Marsh Hawk, the average farmer will benefit by allowing all hawks to feed on the mice in his fields. This is certainly the simplest and cheapest aid to the control of mouse populations.

In the long run protection of the trees until they are eight to ten years old will probably prove to be more satisfactory than attempts to kill all the mice. Control measures involving protection of the trees include:

(1) Clean cultivation of the ground prior to planting.

(2) Cutting and removal of grass, at least semi-annually in areas where mice are present.

(3) Repellents.

Laboratory tests[2] have already suggested a number of compounds which successfully repel rats. Further

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1. Eadie, W.R. Cutting the Cost of Mouse Control. American Fruit Grower, October 1949.

1. Hayne, Don W. Mouse Populations in Orchards and a New Method of Control. Michigan Agricultural Experiment Station Quarterly Bulletin, November, 1950.

2. Roadhouse, L.A.C. Rodent Repellent Studies. Research Council of Ontario, Report 3-3-49, October, 1949.

tests under natural field conditions will have to be carried out on the most promising of these repellents in order to evaluate their efficiency against the meadow mouse, and to ensure that those selected for production would not be toxic to the trees in plantation.

CHAPTER 6

FISH

The purpose of this survey was to make a preliminary examination of the waters of the drainage basin and to classify them as to their present suitability for fish, and secondly to make recommendations for possible improvements.

1. Methods

The river and its tributaries were visited at 291 "stations" corresponding generally to the crossings of the river by roads. The stations were from one to three miles apart. The topographic features of the valley and the erosion, vegetation, volume of flow, turbidity, temperature and type of bottom were listed at each station. At all suitable stations collections of the aquatic insects and other invertebrates were made. At most of the stations collections of fish were also made. The collections were later examined and classified, and were used in zoning the various sections of the river as shown on the accompanying map. The aquatic insects such as mayflies, stoneflies and caddisflies were most useful for this purpose, since many of them are reliable indicators of the stream conditions at the critical time of year. Some species are confined to waters which remain cold and clear in summer, such as trout waters. Others are indicators of permanent flow or of polluted water or of the maximum summer temperature of the water. Thus the potentialities of a stream for particular species of fish are indicated. The fish collections substantiated these findings at their particular stations.

The procedure here adopted follows that used in previous river surveys by the Department of Planning and Development and allows close comparisons of the characteristics of many rivers. The present criteria and methods evolved from more intensive year-round research carried out on parts of the Nottawasaga River and Algonquin Park streams, already reported

on,[1,2,3] and from other unpublished research data made available for this work.

Fifty-two stations on Trout Creek and its tributaries were examined in May 1946. The remainder of the stations could only be examined once. It was therefore necessary to rely on deductions from the presence or absence of species which extensive previous tests have shown to be reliable indicators.

2. The River Valley

The conditions which determine the kinds of fish inhabiting a river are in part a product of the physiographic conditions of the watershed. The more significant points are therefore here emphasized.

A large part of the watershed consists of gently rolling land sharply dissected by deep broad valleys (some of them former glacial spillways) occupied by the main branches of the river. There is however a wide variation in the stream types. Many of the stream courses are now open ditches which are a continuation of tile drains. A few are cool and rapid streams issuing from hillsides at the intersection of gravel soils and more impermeable ones. Between these two extremes many intervening types occur.

The stream bottoms also vary from clean bedrock, found only in the vicinity of St. Marys, through boulders, gravel, sand and silts, to the heavy clay bottom found in the upper waters of Black Creek.

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1. Ide, F.P. The Effect of Temperature on the Distribution of the Mayfly Fauna of a Stream. University of Toronto Studies, Biology 39, Publication Ontario Fish Research Laboratory 50. 1935.

2. Ide, F.P. Distribution of Aquatic Insects in the Lower Reaches of the Credit River. 1934 (Unpublished)

3. Ide, F.P. Quantitative Determination of the Insect Fauna of Rapid Water. University of Toronto Studies, Biology 47, Publication Ontario Fish Research Laboratory 59. 1940.

4. Sprules, W.M. An Ecological Investigation of Stream Insects in Algonquin Park, Ontario. University of Toronto Studies, Biology 56, Publication Ontario Fish Research Laboratory 69. 1947.

The gradients of all the branches are illustrated graphically in the Water section of this report. From the headwaters of the North Branch to London the gradient is 7 feet per mile. The upper 20 miles of the South Branch have a gradient of 11 feet per mile, but the remainder down to London has a fall of only $4\frac{1}{2}$ feet per mile. The gradient of the Middle Branch is 11 feet per mile. Thus while the South Branch between London and Woodstock is sluggish and heavily silted, the North Branch below St. Marys has been more seriously affected by flashy floods and devastating ice action, and the bottom in many sectors consists of stones and boulders with little silt.

The banks of the watercourses are, with very few exceptions, pastured and livestock are commonly watered in the stream.

3. Permanence of Flow

The permanence of flow of the various branches and tributaries of the Thames is shown on the accompanying map Biological Conditions of Streams. Only a small proportion of the watercourses dry up in summer, although many are reduced to a mere trickle. Much of the North Branch and its tributaries in Logan Township and the upper parts of Fish Creek in Hibbert and Usborne Townships dry up completely or to standing pools. But with these and a few other exceptions the branches tend to be small but permanent streams in summer. This is surprising in view of the fact that there are nearly five hundred municipal drains in the agricultural lands of the watershed.

The South Branch provides considerably more flow in summer than the North. In a typical summer the North Branch is reduced to about 25 c.f.s. in its lower reaches and the South Branch to about 40 c.f.s. The smallest daily mean flow recorded was 2 c.f.s. for the North Branch near the Forks in 1918 and the same figure for the South Branch at Ealing in 1919. Such an exceptionally dry year must have had serious effect on the fish populations.

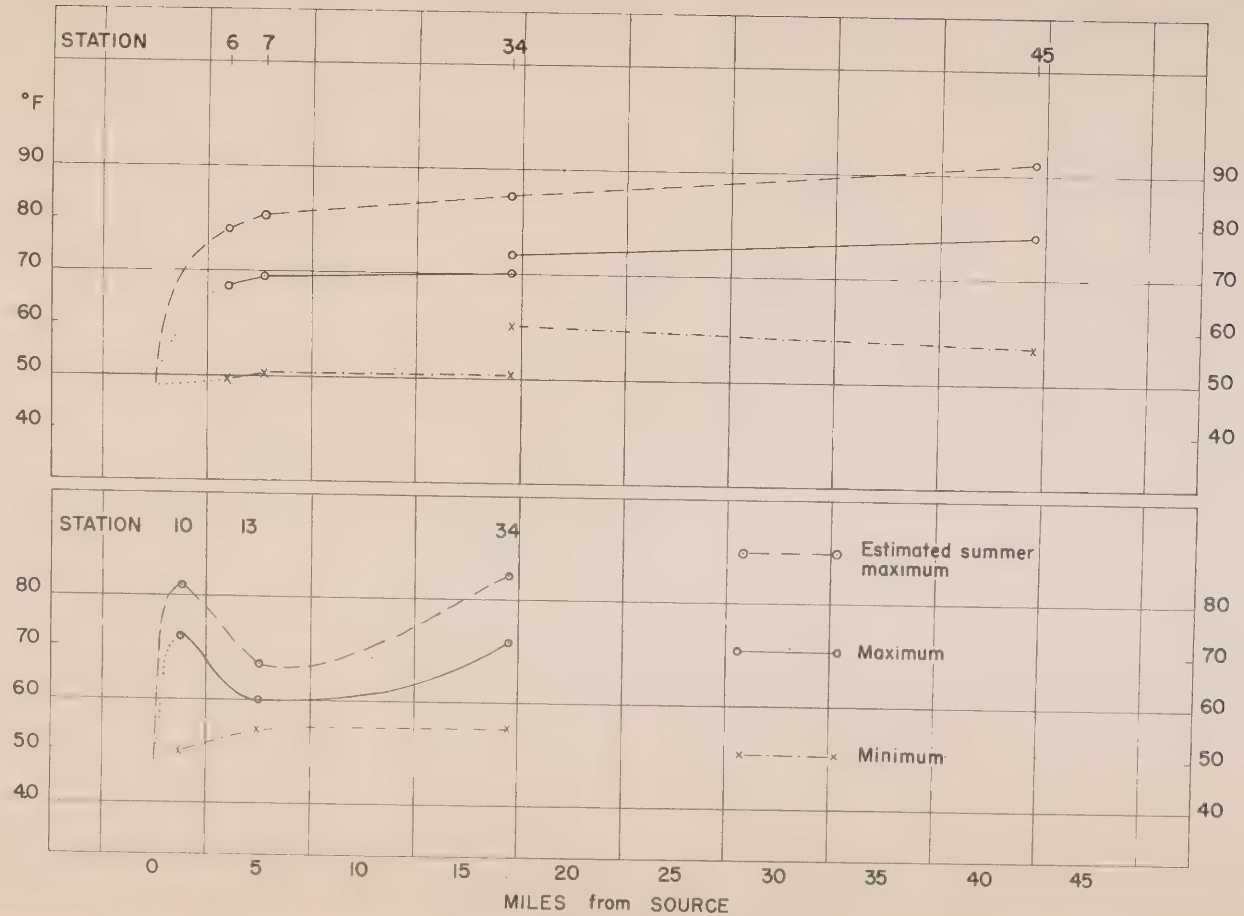
The permanent spring-fed tributaries come chiefly from the intersection of gravelly or sandy morainic overburden and less permeable material lying underneath it. Thus the most important contribution to the summer flow of the river comes from the springs in the Townships of Nissouri East, Zorra West and Zorra East, flowing chiefly into Trout Creek, the Middle Branch of the Thames and the South Branch. There are also excellent springs on Cedar Creek, south of Woodstock, but most of their flow is now piped to Woodstock for municipal needs.

4. Temperature Conditions

Of over a hundred species or groups of aquatic bottom fauna identified, some were distributed at nearly all the places visited. Others, on account of their scarcity, occurred irregularly in collections. The remainder are the ones which were abundant in particular parts of the stream and are indicators of special conditions existing in these parts of the stream throughout the year. Some of the organisms used are listed in the table below:

Some indicator organisms used to determine characteristics of the streams. These are insect larvae or nymphs of mayflies, stone flies, caddisflies and dobson flies.

	Organism	Indicates
1.	Neoperla clymene	Very warm in summer
2.	Corydalis cornutus	"
3.	Baetis intercalaris	"
4.	Stenonema bipunctatum	"
5.	Ephemerella deficiens	Intermediate temperatures in summer
6.	Stenonema heterotarsale	"
7.	Baetis pygmaeus	"
8.	Baetis levitans	Cool
9.	Baetis macdunnoughi	"
10.	Nemoura spps.	Cold in summer, spring fed
11.	Baetis vagans	"
12.	Baetis brunneicolor	"
13.	Hydropsychidae in rapids	Permanent flow in summer



-1947-

COMPARISON of MAXIMUM and MINIMUM WATER TEMPERATURES of LATE MAY and ESTIMATED SUMMER MAXIMA

—TROUT CREEK—

The chief stream temperature characteristics affecting the distribution of fish of the Thames were then deduced and are shown on the accompanying map. The differences in thermal conditions shown result from a variety of causes such as volume of flow, amount of shade and origin of the water, which cannot be individually shown on the map.

Areas suitable for speckled trout do not normally extend beyond the parts of the stream shown in blue. The blue sections have a low maximum temperature, little daily temperature fluctuation and a low daily mean temperature, They also are normally spring-fed and with few exceptions are well shaded in summer.

The high daily maxima and moderate temperature fluctuations in the sections shown in red result normally from a relatively large volume of flow retaining its heat from day to day. Impounded waters in which only the surface water passes over a dam tend to keep the lower stream sections warm.

The greatest daily fluctuations in temperature are found in the sections coloured green on the map. This situation is found some distance down stream from spring-fed tributaries, where there is no longer a cooling effect in daytime, or where no impoundments supply a large volume of warm overflow.

5. Fish Distribution

There are few records of the game fish of the Upper Thames River in pioneer times. The small-mouth black bass is the chief species mentioned in the early literature. It is assumed by many sportsmen that the main stream and larger branches at one time provided a habitat for the speckled trout. This has never been the condition. Edward Talbot[1] in 1824 wrote of this species in the Thames above London: "The few trout retire to the small brooks and rivulets, whose waters seem more congenial to their tastes and habits". Other early writers have subtantiated this evidence.

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1. Edward Allen Talbot. Five Years Residence in Canada. 1824.

The following 42 species of fish were taken in the rivers and streams of the watershed during the surveys.

LIST OF FISHES OF THE THAMES RIVER

(BASED ON COLLECTIONS DURING THE 1946 AND 1950 SURVEYS)

Salmon Family	Salmonidae
* Brown trout	Salmo trutta Linnaeus
* Eastern speckled trout	Salvelinus fontinalis (Mitchill)
Sucker Family	Catostomidae
* Common white sucker	Catostomus commersonnii (Lacépède)
Hogsucker	Hypentelium nigricans (LeSueur)
* Northern redhorse	Moxostoma aureolum (LeSueur)
Minnow Family	Cyprinidae
Carp	Cyprinus carpio Linnaeus
* Creek Chub	Semotilus atromaculatus (Mitchill)
Pearl dace	Margariscus margarita (Cope)
Hornyhead chub	Nocomis biguttatus (Kirtland)
River chub	Nocomis micropogon (Cope)
Blacknose dace	Rhinichthys atratulus (Hermann)
Longnose dace	Rhinichthys cataractae (Valenciennes
Redbelly dace	Chrosomus eos Cope
Golden Shiner	Notemigonus crysoleucas (Mitchill)
Rosyface shiner	Notropis rubellus (Agassiz)
Redfin shiner	Notropis umbratilis (Girard)
Common shiner	Notropis cornutus (Mitchill)
Spotfin shiner	Notropis spilopterus (Cope)
Mimic shiner	Notropis volucellus (Cope)
Blacknose shiner	Notropis heterolepis Eigenmann and Eigenmann
Brassy minnow	Hybognathus hankinsoni Hubbs
Fathead minnow	Pimephales promelas Rafinesque
Bluntnose minnow	Hyborhynchus notatus (Rafinesque)
North American Catfish Family	Ameiuridae
* Brown bullhead	Ameiurus nebulosus (LeSueur)
Stonecat	Noturus flavus Rafinesque
Mud minnow Family	Umbridae
Western mud minnow	Umbra limi (Kirtland)
Pike Family	Esocidae
* Pike	Esox lucius Linnaeus
Perch Family	Percidae
Yellow Perch	Perca flavescens (Mitchill)
Blackside darter	Hadropterus maculatus (Girard)
Johnny darter	Boleosoma nigrum (Rafinesque)
Iowa darter	Poecilichthys exilis (Girard)
Rainbow darter	Peocilichthys caeruleus (Storer)
Fan-tail darter	Catonotus flabellaris (Rafinesque)
Least darter	Microperca microperca (Jordan and Gilbert)

This tributary of the Avon was formerly an excellent trout stream. It has been ditched and straightened to the point where it is now too wide, too shallow and too straight, and lacks pools, logs, boulders or other cover. It remains a cold stream, and is well shaded in summer, but its productivity is limited.

This sector of the Avon River above Stratford now lacks both shade and protective cover such as boulders or roots in the water.

The Harrington stream, in Zorra West Township, still provides excellent conditions for speckled trout. There is a shortage of deep pools in this stream. If deflectors were installed so as to form a few deep pools, the stream could be expected to produce larger trout.

Sunfish Family	Centrarchidae
* Small-mouth bass	Micropterus dolomieu (Lacépède)
* Green sunfish	Lepomis cyanellus Rafinesque
* Pumpkinseed	Lepomis gibbosus (Linnaeus)
* Bluegill	Lepomis macrochirus Rafinesque
* Long-ear sunfish	Lepomis megalotis (Rafinesque)
* Rock bass	Ambloplites rupestris (Rafinesque)
Sculpin Family	Cottidae
Muddler	Cottus bairdii Girard
Stickleback Family	Gasterosteidae
Brook stickleback	Eucalia inconstans (Kirtland)

The arrangement follows that of Dymond, J.R. "A list of the Freshwater Fishes of Canada East of the Rocky Mountains" (Misc. Publication #1, Royal Ontario Museum of Zoology, Toronto), 1947.

Species of particular interest to anglers are starred.

The distribution of fish in the Thames is affected by the severe pollution in various sectors of the river. These sectors are shown on the map "Biological Conditions of Streams". The present pollution of the Thames and the means to prevent it are discussed in the chapter "Pollution" in the Water section of this report. While there is considerable industrial pollution, it is insignificant when compared with the effects of effluents of the many overloaded sewage plants.

Fourteen cheese factories or creameries are listed as having inefficient waste disposal systems. Some of these regularly pollute the river or tributaries to the point where fish cannot survive. Others discharge wastes into ditches which have normally no flow but pollute the river after rainfall. In either case efficient septic tanks and settling beds or field-tile beds should be installed.

The brown bullhead was not collected during the survey but was included on the basis of reports from several anglers. The yellow bullhead may also be present. The absence of these species may be explained by the fact that extensive seining was not carried out in the deeper and muddier parts of the river.

The pike-perch (pickerel) was not collected, although more than a million spawn of this species have been put into the river at various times, and at intervals a few have been reported caught. If present it must certainly be an uncommon fish in the river.

The distribution of the major game fish species in the river, based on the 1946 and 1950 collections, is shown on the accompanying map. Further collecting or angling would of course increase the known range of some of the species. Some species, e.g. speckled trout, are more difficult to catch than others. Smaller and younger fish are also more numerous and easier to catch than larger or older ones. Hence the map does not provide a close estimate of the relative numbers of the different species or of the locations where fish of legal size will be found.

The small-mouth bass is the most sought-after species in the watershed. Other species less often fished for are pike, pike-perch (pickerel), speckled trout and chub.

Small-mouth bass were found to be well distributed through the watershed. They were common in the main stream of the North Branch and most of its tributaries, and were also found in the South Branch (apart from the heavily polluted sections) down as far as Nilestown, and in the Middle Branch below Embro. Rock bass were also widely distributed and were taken at more than 100 stations. Speckled trout were noted at 11 stations only. These were in cold tributaries of Trout Creek, the Avon, Wel.burn Creek, the upper waters of Medway Creek, a tributary south of Fullarton and in a small stream near Komoka.

Three species of sunfish were taken, the pumpkin-seed rather generally distributed on the watershed and the green or long-ear restricted to the warm section and local.

The creek chub was taken at two-thirds of all the stations visited and apparently had the widest distribution of any fish species. Pike were taken in the South Branch, in

Waubuno Creek and in Fish Creek. With every allowance for the difficulty of catching pike in seines, they do not appear to be common in the river.

Of the sucker family, the common sucker was generally distributed and was found at nearly 200 stations, the hogsucker was found at 54 stations, chiefly on the North Branch, and the redhorse sucker was taken at 12 stations, also chiefly in the North Branch.

A single carp was taken. This species is seldom caught in short seines. Most of the remaining species were dace, shiners, minnows, darters and other small fish not of special interest to the angler.

The Michigan brook lamprey, a non-parasitic species belonging to a primitive group of fishes, was also collected at 3 stations on Trout Creek.

6. Detailed Studies: Trout Creek

Trout Creek was studied in 1946 in greater detail than has been given to the remainder of the Upper Thames. This report, therefore, discusses it in some detail as an example of the treatment and recommendations which might be applied to other tributaries. The creek is about twenty-five miles long, with an average gradient of seven and a half feet per mile. The eight tributaries are named A to H on the accompanying map.

(a) Tributaries

A. This tributary has two branches and flows through open fields. It dries up completely in dry summers. Further data on this stream are given in Table II together with comparable data on the other tributaries.

B. Arising in drains in cultivated land in two branches, this tributary flows through open country with little woodland along its course. In its upper parts the stream flows through flat land with low perpendicular banks eroded by the spring floods. In its lower reaches a narrow valley has been formed with banks about thirty feet high. The stream is warm

in summer and dries up in time of drought.

C. Several small cool streamlets combine to form this tributary. They flow through farmland in shallow valleys and there is little protection from the sun. (See Table I, Station 10.) It appears to be permanent, though of small volume of flow. Further downstream the tributary flows through wet swampland where the water is protected by dense tree growth so that its temperature falls (Table I, Station 13). Traversing the swamp the water becomes brown, differing in this respect from the other tributaries, and has a low oxygen content. From the swamp to the junction with the main river, this branch has been ditched and food organisms for fish are scarce.

Tributary D arises in hilly country and has a steep gradient but has little tree protection and dries up in summer. Branches E, F, G, and H are spring-fed in the hilly well-wooded country near Harrington West. From one to three miles long, they all have a small but permanent flow. They are suitable for speckled trout, and this species was taken in three of them, together with other fish which are normally associated with trout. The G stream is the largest of the four and formerly had a dam, forming Harrington Pond in its lower section. Such a pond greatly increases the space for trout and, with a properly designed dam, will not seriously affect the temperature of the stream below it.

The upper part of the main creek arises in a swamp east of Stratford and flows several miles through open ditches so that its water becomes warm except locally where springs enter. It is a permanent stream, but its temperature increases downstream until it is joined by Tributaries C, E, F, G and H, whose waters cool the main stream considerably. This effect is increased considerably by the greater tree cover downstream. Below the mouth of Tributary H, the termperature of Trout Creek rises rapidly. In the lower part of its course the stream runs in a deep valley which has a flat alluvial bottom.

As the stream nears St. Marys the valley has become wide and shallow. The bottom of the stream is soft and silty in the upper part, but in the lower sections, stony reaches with frequent clean riffles alternate with slow-flowing parts with silted bottom. The stones are thickly encrusted with marl.

TABLE II

CHARACTERISTICS OF TROUT CREEK AND TRIBUTARIES

Tributary	Length (Miles)	Average Gradient (Ft. per Mi.)	Vol. of Flow in Late May (C.F.S.)	Flow	Temp.
A	1.7	5	1	Intermittent	Warm
B	3.5	17	3	"	"
C	5.7	17	6	Permanent	Cool
D	1.8	55	2	"	"
E	3.0	12	2	"	Cold
F	1.0	60	2	"	"
G	3.5	25	5	"	"
H	2.7	45	1	"	"
Main Creek	27.0	8.5	40	Permanent	Warm

(b) Deficiencies in Trout Creek

Of all the tributaries of the North Thames, Trout Creek offers the best trout waters, but even here they are not extensive. The few streams remaining are all small, supporting a few fish of small size. The main stream, now too warm for trout in summer, was a good speckled trout stream in former times. Although it now produces small-mouth bass, there is too little natural fish cover such as pools and logs for this fish to be abundant.

Of the tributaries, some are now dry in summer and many are subjected to direct heating of the sun. There is also considerable erosion, even in the upper parts, from the cutting of the banks in flood time. This results in the accumulation of silt downstream and turbid water during flooding,

DEMONSTRATION PROJECT
CONSERVE AND PROTECT

★ ═══ ★

IF YOU ARE A TRUE SPORTSMAN YOU WILL KNOW AND OBSERVE:

1. Trout under seven inches in length are NOT kept, but returned carefully to the water. (This can be done if you will wet your hands and remove the fish from the hook under water.)
2. Trout under seven inches in length have NOT spawned and when killed, the Trout population in this stream has been reduced by several hundreds.
3. If you are fishing with worms or other bait, try using barbless hooks; we will guarantee you will catch as many fish and will find that undersized Trout can be released much easier, thus they won't be so seriously hurt.
4. YOU are fishing to-day on this Trout stream through the courtesy of the owner of the property on which you stand to read this. Be a good sportsman and return the courtesy when passing through, by leaving fences undamaged; gates or bars as you found them; and the stream unpolluted.
5. THINK AHEAD – We, and our children have a wonderful natural heritage here, so let's all be conservation-wise and keep Trout Fishing enjoyable and beneficial for many years to come. It so happens that this is one of the very few recreations in which the individual plays every position on the team, and where the ultimate "score" rests entirely on the fisherman's own ability to "play the game".
6. Thank you for reading this far; you will feel much better if you will observe these simple courtesies and humane rules.

"IT IS JUST PLAIN COMMON SENSE"

★ ═══ ★

Crumlin Junior & Senior Sportsmen's Assoc.

Member Club of Middlesex County Sportsmen's Association

One of the greatest problems in hunting and fishing in Southern Ontario is the natural hostility of farmers towards those "sportsmen" who disregard conservation regulations and also damage farmers' property.

This presents a challenge to sportsmen's clubs. The real solution is education of sportsmen. Many sportsmen's clubs are alert to this need. The above illustration is an example, rare in Ontario, of a determined effort by a sportsmen's association in the Thames Watershed to interest the public in conserving fish and improving farmer-sportsman relations. The notice, much enlarged and printed on heavy cards, was posted by the roadside at each crossing of several trout streams.

both of which are detrimental to the organisms on which the trout would feed.

(c) Improvements Needed in Trout Creek

Tributaries C, D and H would be improved by the planting of trees and shrubs lining the banks and overhanging the stream to shade the water and to keep it cool.

The trout tributaries E, F, G, and H are small streams which have cover and food for a few small fish only. Dams placed near their lower ends, impounding small ponds of an acre or two, would increase the trout production and provide unobstructed angling. These dams should be constructed according to specifications for trout pond dams. The outlet of each dam should be a pipe constructed so that cold water is drained from the bottom and the warm surface water is not allowed to flow over the dam. By this method the water below the pond is not unduly warm as it would otherwise be. From the screened intake at the bottom of the pond the outlet pipe should rise close to the normal surface level and there pass through the dam. Excess water would pass over the spillway.

The cooler part of the main creek, adjacent and down stream for a short distance from the mouths of tributaries D, E, F, G, and H, could be planted with brown trout. More pools for cover would improve this section. To create these pools low dams or deflectors of the types shown in the accompanying illustrations should be constructed. Some of these may be of log and others of concrete and stone construction. The deflector type is more suitable for the trout section since it does not interfere with movements of the fish and also does not impound the water to the same extent with a resulting increase in temperature.

Below this section and on down into the proposed reservoir above St. Marys, conditions are suitable for one of the bass species. In this section crayfish are abundant. These are a staple food of the small-mouth bass. Low dams should be constructed in suitable places in this reach.

Michigan Dept. of Conservation

Single-wing deflectors in a trout stream. These are log cribs 30 inches wide and 30 inches high. The logs are wired and stapled to posts. Log spreaders are placed at intervals along the structure. The interior space is filled with gravel and sand, and the top is well sodded to prevent surface erosion and to improve the appearance. The wings are installed at an angle of 35°-45° to the direction of the stream, with the terminal end down stream from the base.

Michigan Dept. of Conservation

Single wing deflector made of three logs fastened together and staked securely to the bottom. Opposite this deflector a log bank cover can be seen. This is now partly overgrown with sod and brush. A bar has already started to form below the deflector. This device has proved a very effective stream improvement.

Figure 2 shows diagrammatically a section of Trout Creek from G tributary to St. Marys with suggested dams and other improvements.

The types of improvements described for Trout Creek can of course be applied to many of the smaller streams in the watershed. Good management of the soil and of the forest cover, and the planting of trees for shade above the streams, should result in a considerable increase in the range of the speckled trout in the watershed.

Of all the phases of conservation, stream improvement requires the greatest measure of co-operation, since the manner in which watercourses are managed up stream so radically affects all the owners down stream.

7. Improvements for the Main River and Flood Control Basins

In the main North Thames the production of bass might be improved by low dams. The large impoundments which it is proposed to construct, as outlined in the Hydraulic report, will have extensive shallow areas which will support aquatic plants. It is recommended that large-mouth bass (*Huro salmoides*), a species adapted to weedy places, might be introduced to these ponds. Another fish adapted to warm weedy waters which has been little utilized in this province but has been grown with considerable success in warm ponds in Ohio and other States, the calico bass or black crappy (*Pomoxis nigromaculatus*), might be introduced in these ponds.

Since these large dams are placed well down stream in sections whose waters are well warmed up, they would not greatly affect the conditions in the river below them, even if their outflow consisted of surface water. From the biological and fisheries standpoint, however, it is imperative that a flow of water be maintained at all times throughout the length of the river, even during the construction and filling period, as any interruption in the flow would eliminate a large proportion of the organisms on which the fish feed and these organisms if

once eliminated from a reach would not re-establish themselves for many years.

8. Farm Fish Ponds

Few of the farm fish ponds now existing on the Thames Watershed produce a useful yield. There is ample room for improvement of this type of fishing.

The chief research on management of farm fish ponds has been carried on in southern and warmer climates, and therefore the findings cannot be applied without qualification to an area having the climate of Southern Ontario, but some definite recommendations may be made. The most favourable locations for the construction of farm ponds in the watershed are shown on the map of Pond Regions in the Farm Ponds section of this report. Suitable methods for the construction of six types of farm pond are also given in that section.

From the fisherman's point of view, farm ponds are of two main kinds[1]. The first is the cool pond with continuous inflowing water and maximum temperatures at the surface of about 75° Fahrenheit with cooler bottom. Ponds of this type are usually successful near the headwaters and may range in size from about an acre to 8 or 10 acres. Depth should be 10 feet or more in the deepest part. Spring flow of as low as half a cubic foot per second will maintain a pond of one acre. This type of pond is best adapted to the production of speckled trout or brown trout. These species of trout do not normally reproduce in ponds and must be maintained by periodic restocking. Ponds cold enough for trout should be stocked only with trout and the two species of trout should not be mixed.

The second and commoner type of farm pond is the warm water pond. Most farms have at least one low spot

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1. An excellent handbook on the details of construction and management of farm fish ponds is "Fish Ponds for the Farm" by F.C. Edminster, published by Charles Scribner's Sons, New York 1947. Some of the above information is abstracted from this bulletin.

suitable for a fish pond. It is frequently good practice to have separate ponds devoted to wildlife and fish and to control the aquatic plants in the fish pond.

In managing warm water ponds for fish the following points should be kept in mind.

(1) A minimum depth of 10 feet over at least 25 per cent of the pond should be planned to avoid excessive winter kill, probably the critical factor in fish survival in farm ponds in Ontario.

(2) If suckers, carp or large numbers of minnows are already present in the pond, it is usually best to destroy all fish in the pond.

(3) It is often necessary to control existing aquatic vegetation. There are both mechanical and chemical methods available[1].

(4) There have been few tests made in Ontario of the efficiency of applications of fertilizer in increasing the crop of plankton, the smaller aquatic invertebrates. The research now being carried out in this field may lead to application of fertilizers such as 8-8-4 becoming more general.

(5) Since many of the species commonly recommended for introduction grow very slowly in Ontario waters, research to determine the most satisfactory species in this province will be needed. New ponds and those in which the previous fish have been destroyed might be stocked experimentally with a combination of large-mouth bass (Huro salmoides) and bluegills (Lepomis machrochirus) at the rate of 100 bass and 1,000 bluegills per acre. Fishing should be deferred until some of each species have spawned successfully.

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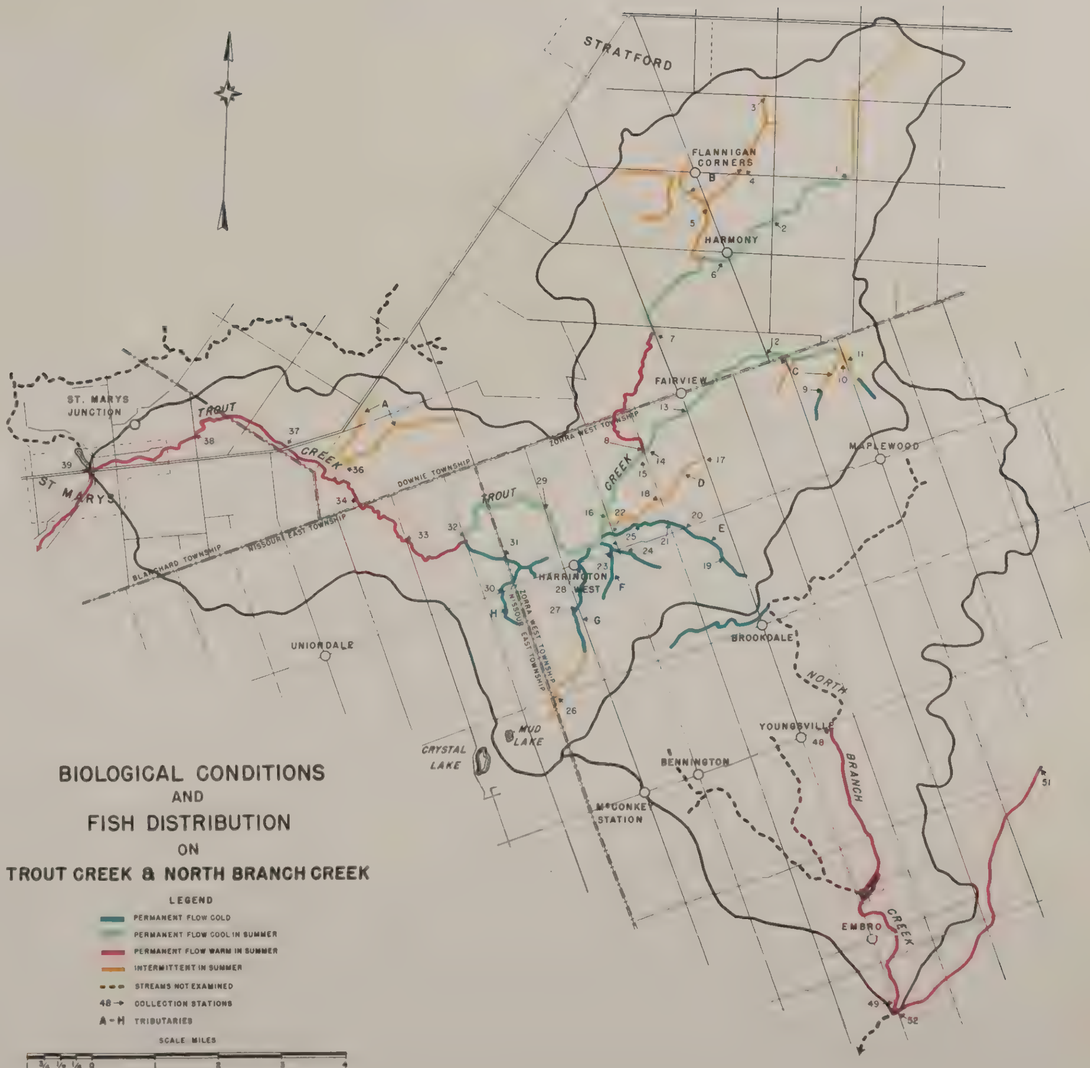
1. Speirs, J. Murray. Summary of Literature on Aquatic Weed Control. Canadian Fish Culturist, 3:(4); August 1948.



BIOLOGICAL CONDITIONS AND FISH DISTRIBUTION ON TROUT CREEK & NORTH BRANCH CREEK

RECREATION

CHAPTER 1

THE APPROACH TO THE PROBLEM

1. Objectives

The planning of recreation facilities in Ontario has in the past been chiefly directed towards two ends: facilities such as parks and playgrounds within the boundaries of cities and towns, and facilities for long and comparatively expensive vacations in wilderness regions relatively far from the industrial and agricultural areas of the Province. The growing concentration of the population in industrial areas has overtaxed the local facilities, while the time and cost involved in reaching wilderness areas have prevented the average family or group from visiting such areas more than once or twice a year.

It is now well recognized that a third type of facility has been neglected - the public area within a few miles of the agricultural or urban worker's home. The lack of good recreation facilities close to the cities has been an obstacle to the enjoyment of healthy out-of-door activities and relaxation. One objective of this report is therefore to consider the development of public recreation areas outside the towns and cities in the Upper Thames Watershed. Inevitably some form of control of such areas, either by the application of zoning by-laws or by acquisition, is involved.

In the preparation of the report, three points have been kept in view:

(a) The retaining and protection of natural advantages.

(b) The development of adequate facilities in maximum variety, available to people of all ages, tastes and income groups.

(c) The adjustment of recreation plans to any other conservation measures proposed for the Thames and neighbouring watersheds.

Small urban parks and playgrounds hardly fall within the scope of the present study. The larger urban parks are of course considered in their relation to an overall parks plan.

The provision of opportunities for recreation on the lands and waters of the Thames Watershed is of course a public responsibility requiring long-term planning.

2. Distribution of Population

In planning for recreation the density of population over different areas of the watershed must be carefully considered. Several factors appear to be important.

The first is that the dominant population of the watershed is urban. Of the 190,000 population of the watershed, 138,000 or 70 per cent of the total live in three cities and three towns, namely London, Stratford, Woodstock, Ingersoll, St. Marys and Mitchell. The second is that more than 50 per cent of the population live within five miles of the centre of the city of London; and the third is that even the rural population tends to be denser in the southern part of the watershed than elsewhere, as shown by the population map which accompanies this report.

Areas for recreation must obviously be located as close to centres of population as possible. It is therefore clear that while the northern part of the watershed must not be neglected, the need for recreation facilities in the south-western part of the watershed is greatest.

3. Types of Recreation Facilities

The kinds of recreation facilities commonly considered are as follows:

- (a) Beaches and pools for swimming
- (b) Beaches developed for children's use
- (c) Boating and fishing areas
- (d) Individual picnic sites and group picnic grounds in parks
- (e) Roadside picnic sites
- (f) Scenic drives
- (g) Individual and group camping areas
- (h) Trails for riding, hiking and nature study
- (i) Public hunting areas
- (j) Winter sports areas
- (k) Arboretums[1]
- (l) Youth Hostels[1]

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1. These are described in more detail in Chapter 2.

(m) Swimming holes
(n) Historic sites
(o) Public golf courses

For many uses land acquisition is the primary, and sometimes the only, requirement. In addition, such measures as pollution control, supervision of public swimming areas, planting of shade trees and many other services may be needed.

Many of these uses can be integrated in a broad plan of land zoning for health and recreation. In all growing communities a long-range plan must be made with an eye to the future needs of the population. The amount of park lands and the location of them in relation to the centres of population are obviously of great importance. Modern master plans for both large and small cities now commonly include a zone of land called a Green Belt surrounding the inner metropolitan area and intended to provide space for many kinds of outdoor activities. Where strict zoning regulations are to be maintained some of this land may remain in private hands. Otherwise public acquisition is the only guarantee of proper use.

If the projected growth of the city of London would warrant a Green Belt in the future, the value of a long-range plan cannot be overestimated. Areas just outside the city can be restricted or acquired before they reach a high value as real estate. A typical example of an area which would have been suitable for a Green Belt is the land east and west of, and including, the Walker Ponds south of London. This area is now being occupied by the new hospital or otherwise built up.

4. <u>Pollution of Watercourses</u>

There is a rapidly growing need in Ontario for the reduction of present pollution and for prevention or control of proposed new outlets. Pollution on the Thames is discussed in detail in the section of this report on Water.

CHAPTER 2

EXISTING FACILITIES

1. Urban Facilities

It is not the purpose of this report to make plans for recreation within the urban areas. The planning of such recreation is already in the hands of a number of capable organizations. Some instances will indicate the type of organization and the facilities provided in different centres.

The largest organization having recreation within its scope is the London Youth Council. This Council has representatives from all the major interested groups such as the churches, Y.M.C.A. and Y.W.C.A., service clubs, schools, athletic clubs of industrial firms and the Public Utilities Commission of the city, under which an extensive park system is organized.

The City of London already owns 654 acres of land devoted to recreation, consisting of 417 acres of parkland, 125 acres of supervised playground areas and a public golf course of 112 acres. It is regrettable that of this total 465 acres or 71 per cent lie well outside the city limits. The city has a great asset in Springbank Park. Although it lies three miles from the city it is intensively used. It is attractively landscaped and has excellent playgrounds and ample shade. The only factor which seriously prevents full use of this park is the condition of the river, which is severely polluted.

The City of Stratford has the best example of completed land planning for recreation in the watershed. Victoria Lake, formed by the damming of the Avon River, and the parks and playgrounds along its banks are extremely attractive and a credit to those who planned them at a time when other centres were allowing industrial development to mar the river banks. The development here is a good example

This lake and the park surrounding it at Stratford were planned forty-seven years ago at a time when other planners were allowing industrial development to mar the river banks.

Facilities provided in the park include both play areas for intensive use and restful scenes such as this.

The lake is much used for boating. It also provides a home for Black Ducks and swans.

of the wedge type of parkland recommended by many modern planners. Open land continues in a narrowing wedge right into the centre of the city. As well as its beautiful lake, Stratford has a total of ten parks and a fairground, including 125 acres. There is also a municipal golf course. Additional recreation areas are being planned.

The City of Woodstock has four parks totalling 61 acres, a fairground of 30 acres and a private golf course. Southside Park is well developed for both separate and group picnics and includes facilities for canoeing, swimming and field sports. There is also a separate section for camping, with kitchen supplied.

Ingersoll has two parks totalling 21 acres - Memorial Park with picnic ground and children's playground and Victoria Park with sportsfields and fairgrounds.

St. Marys has 21 acres of parks, including a fairground. It has already developed one of its two flooded quarries to form a very fine natural swimming pool and has plans for further development.

The Town of Mitchell has taken a commendable step in developing a Community Centre of 22 acres, with a fine natural site and with facilities for all kinds of sports and an exceptionally well designed swimming pool and bathhouse. The town also has a 19-acre fairground with additional sportsfields. When the work is completed the Community Centre may well be a model for other centres in Western Ontario to follow. Credit for this development should go to an exceptionally enterprising Lions' Club.

2. Rural Facilities

(a) Beaches and Lakes

At present a considerable number of people in the area go south to the Lake Erie beaches or to Lake Huron, fifty miles away. These lakes, however, are too far for an afternoon outing. Outside the towns there are at present no

publicly owned beaches in the watershed. There are, however, a number of small lakes and ponds in the area, the ownership and size of which are as follows:

Name	Ownership	Acreage
St. Marys Quarry	Public	10
Walker Pond 1	Hospital grounds	12
Walker Pond 2	Private (Angling Club)	18
Walker Pond 3	Hospital grounds	12
Mill Pond (Westminster)	Private	34
Foster Pond	Private	16
Beattie Pond	Private	4
Mud Lake (Dorchester Tp.)	Private and inaccessible	20
Quarry Pond (Beachville)	Private	28
Reservoir west of Ingersoll	Private	25
Embro Mill Pond	Private, some swimming allowed	20
Hodges Mill Pond	Private	58
Crystal Lake (Lakeside)	Partly subdivided, partly available with permission	65
Mud Lake (Nissouri E.)	Private and inaccessible	7
Lakes east of Stratford	Private	30
Mill Pond at Dorchester	Private, partly in commercial hands and available for picnics	26
Arva Mill Pond	Private	30
Innerkip Quarry	Private, swimming allowed	14
Victoria Lake (Stratford)	Public	30
		443

Two facts can be seen from the above list. The first is that apart from river courses the total lake and pond water in the watershed is only about three-quarters of a square mile. The second is that two only out of 19 lakes and ponds are now in public ownership. Many of them are posted against intruders.

(b) Picnic Sites and Camping Areas

There are still some excellent picnic sites along the river courses in the watershed. However, none of these are public property. The best sites, set in attractive scenery, include old pastures with large shade trees. Since the areas are normally pastured, there are no young trees other than hawthorn growing up to take the place of the present trees when they eventually fall or are cut down. The result is that good picnic sites are becoming progressively rarer. Many of the best sites in the vicinity of London are already

in the hands of private owners from the city who do not allow visitors.

Camping areas are of two types, the community camping area for use by groups and the individual camping site with emphasis on the privacy which a family appreciates. As far as is known there are no public camping areas outside municipal boundaries in the watershed.

(c) Nature Trails and Arboretums

Nature trails are marked paths intended to help the average citizen to appreciate the interesting and attractive side of natural history. Such features as trees, plant and animal communities, rock formations, old beaver dams, and other natural phenomena are named or explained with suitable markers. A beginning in this work has been made at Springbank Park, London, but nowhere else in the watershed.

An arboretum is a collection of living trees and should include as many of the native tree species of the Province as possible and interesting exotic species. Arboretums are both attractive parks and useful in conservation education.

(d) Youth Hostels

The Canadian Youth Hostels Association is part of an international non-profit organization operating in 25 countries. It organizes well-supervised sleeping quarters (with cooking facilities) away from urban areas and available for a small fee, so that hikers, cyclists and skiers can enjoy the open country and meet others of similar tastes in attractive surroundings. There are several regional executive committees, as well as a national Board of Trustees, composed of men and women prominent in educational and welfare work. This organization does not cater to those who travel by car.

Youth Hostels are normally established in chains 10 to 20 miles apart. At present there are two Youth Hostels established in the watershed, one near St. Marys and another at Woodstock. Membership in the Youth Hostels Association is rapidly growing in Ontario.

(e) Scenic Drives

There are several very attractive drives in the watershed, particularly those following the North Branch of the Thames River north and south of St. Marys, the road east and west of Dorchester, and the part of the county line between Perth and Oxford Counties, east of Fairview. Such scenic drives should have occasional pull-outs, where a car may be driven off the highway, but there are none available at the present time.

(f) Historic Sites

Four tablets have been installed by the Historic Sites Commission of the National Parks Bureau. None are of importance to rural recreation facilities. Three in London commemorate distinguished persons. The fourth, at Ingersoll, notes the establishment of the first cheese factory in Canada. Several cairns and markers have been set up by local bodies. One commemorates the foundation of Mitchell, another records the original Seebach family settlement, and a third, at Shakespeare, notes the beginnings of the village.

With these exceptions there are no publicly owned historic sites in the watershed.

CHAPTER 3

RECOMMENDED FACILITIES

While the population of other centres in the watershed has tended in the past thirty years to increase slowly or to be stationary, that of London has shown a consistently sharp increase and will certainly continue to do so for some time. This will produce a great strain on the recreational facilities available in the area. It is also true that many of the best natural sites for recreation in the land surrounding London and throughout the watershed are no longer available for acquisition by the community, having already been bought up for private estates. Since the tendency continues in this direction, it is important that early action should be taken to ensure public ownership for some of the remaining beach, park and picnic sites.

(1) Thames Valley Park

The valley of the North Branch of the Thames between London and St. Marys contains some of the most attractive scenery in the watershed. It is easily accessible from London by several routes. Since lands must be acquired for flood storage in the valley above the Fanshawe Damsite the time is opportune for the establishment of a large park which would surround the flood storage area, and might eventually include parts of the whole valley stretching some thirteen miles northward to No. 7 Highway near Prospect Hill. The dam now to be built will create a permanent lake which will provide good fishing as well as boating and swimming.

The accompanying maps show in detail the part of the valley which has already been planned as an intensive use area by the Authority's Parks and Recreation Advisory Board.

RECREATION

RECOMMENDED FACILITIES

LEGEND

THAMES VALLEY PARK
POSSIBLE EXTENSION OF T.V.P.
PICNIC SITES
HISTORIC SITES
EXISTING YOUTH HOSTELS
PROPOSED YOUTH HOSTELS

EXISTING LAKES —
CLOSED TO THE PUBLIC
PRIVATELY OWNED BUT OCCASIONALLY USED BY THE PUBLIC
OPEN TO THE PUBLIC

SCALE - MILES
1 0 1 2 3 4 5

The boundaries of the intensive use area have here been slightly modified to take advantage of the existing property boundaries rather than of existing fences, in order to simplify land purchase.

In the land use survey of the watershed, described elsewhere in this report, the parts of the watershed which should be restricted to forestry or permanent pasture were mapped. A large part of the valley and steep slopes along the North Branch between the Fanshawe Damsite and St. Marys came under this heading. These areas are shaded on the accompanying park map. The findings should be a very valuable aid in the selection of additional areas for park use, since they take into account not only the soil type, slope, degree of erosion and drainage, but also the present land use.

The section of the valley between No. 7 Highway and the mouth of Fish Creek, which is recommended in the Forestry section of this report for acquisition and reforestation, is shown on the park map. Several smaller areas are also shown which are particularly suitable for reforestation but which are not listed in the Forestry section because of their small size. Existing woodlands, chiefly overgrazed, occupy 90 acres of the intensive use area and 320 acres in the northern section. Much of the remainder is stony pasture or unused land with patches of hawthorn trees. The chief questions which would require examination in detail in setting up the park are therefore the value of the pasture land, standing timber and rights to water cattle, and the costs of necessary improvements and maintenance. Within the boundaries of the park, the following facilities could be made available:

(a) Swimming and Boating Facilities

The permanent lake will have an area of 650 acres. It will be four miles long and will have a

A view of the North Branch of the Thames River in the proposed extension of the Thames Valley Park. The flat lands at the top of the hill would be outside the park boundary.

The Green Heron, Spotted Sandpiper and other shore birds are common along this stretch of the North Branch of the Thames River in the proposed park. The preservation and wider spread of interesting species of animals should be a major objective in park management.

maximum width of half a mile. Most of the lake will be more than six feet deep. Some water may be drawn from the lake for the municipal requirements of the City of London but the level of the lake will not be seriously affected. Summer storms may raise the lake a maximum of six feet. Since total variations of about eight feet are possible (apart from the spring floods), the docks will presumably be of the floating type. Some mud flats will probably be inevitable in the upper reaches of the lake, but there will be many parts of the lake where excellent facilities for diving and water sports can be provided.

(b) Beaches and Wading Areas for Children

It would be necessary to make one or more artificial sand beaches. This might not be feasible in the more northerly stretches of the river beyond the impounded water, since the spring floods would tend to remove the sand, but it could easily be achieved along the quiet water of the lake.

(c) Parkways

The upper stretches of the river valley lend themselves to attractive parkways. The modern practice in planning such drives along rivers is to restrict the drives to one side of the river, leaving the other side as an unspoiled area to which there is access by car at a few points only. In this case the main drive should follow the west bank of the river, since it has better views and part of the present road system already follows the upper edge of the valley slopes on that side. Parking places would be provided at those points on the drive which have exceptional views.

(d) Picnic Sites

Both group and individual picnic sites should be developed. Those which are in wooded areas

would have the usual type of cemented fireplace, similar to those now supplied by the Province of Ontario at camping sites in many parts of Northern Ontario. Sites selected for group picnicking would also be provided with rough benches and tables.

(e) Camping Sites

There are a number of attractive camping sites along the river which could easily be developed, but the critical factor would be location of spring water. Neither the Thames River nor the artificial lake can be expected to provide water suitable for drinking without extensive treatment, since the Avon now carries all the partly-treated sewage from Stratford, and since the Main Branch now undergoes serious pollution at Mitchell and minor pollution at several other points above the park. Reliable springs are therefore essential for campers. Cemented fireplaces would be a necessity. Camping sites in public areas should, if possible, be provided with fuelwood cut and piled. Otherwise, live trees are likely to be destroyed or damaged. In practice this has not been an expensive item of parks management elsewhere.

(f) Nature Trails

The extension of the park in Concessions II and III, Lots 27 to 30, in Nissouri West Township is an area in which a nature trail should be laid out. This could be marked and also perhaps maintained by any of several Boy Scout troops in the watershed. A second nature trail could be located near the damsite and close to the city of London. Such trails offer a very useful addition to the educational facilities of the various municipalities.

(g) Winter Sports

There are excellent opportunities for ski trails to be opened at both the north and south ends of the park. The park would of course be open for all winter sports, including skating.

(h) Youth Hostels

The nearest Youth Hostel to the park is that at St. Marys. It is probable that there would be sufficient demand for overnight accommodation near the northern part of the park to warrant one or two more Youth Hostels being located in the neighbourhood of Thorndale or Plover Mills.

(i) Reforestation

There are two types of tree-planting needed in the park and its northward extension. Much of the planting in the intensive use area would be in groups of trees rather than reforestation in solid blocks, and would have to be carried out by trained men, but some of the larger blocks and most of the reforestation proper in the northerly extension of the park could be carried out as part of an educational conservation program. Individual schools, Scout troops and other organizations could be encouraged to plant small areas annually. This type of education has already been given prominence in Simcoe County, where Boy Scouts have planted a million and a quarter trees, and has proved of great value in teaching the principles of proper land use and woodlot conservation. There is also ample scope in the park for small projects of erosion control.

(j) Park Administration

The preliminary plan provided by the Parks and Recreation Advisory Board of the Authority already includes suitable sites for an administration building, boathouses, park service buildings, an amphitheatre, a trailer camp and an athletic field. Many of the park services could be modelled on those now used in the parks surrounding the impoundments of the Muskingum Watershed Conservancy in Ohio. These services have been exceedingly successful and have also provided enough profit to the

Conservancy to pay for some of the improvements in the parks. Small fees are charged not only for boat rentals or licences and for camping or trailer facilities, but also for overnight or weekly rentals of cabins near the lake. Where cabins or refreshment pavilions of this type are operated by concession rather than directly by the Authority, it is usual to set minimum standards both for the design of the buildings and the operation of the services. It is best for the Authority to be responsible for both the design and the construction of such buildings. Where a park will be very intensively used, as the Thames Valley Park certainly will, the allocation of restricted parts for summer cottages on long leases seems hardly justified. This should certainly not be the primary or even a major purpose in establishing a park so close to a large population centre.

While lands should be acquired for a park, such as is planned, as quickly as possible, improvements should be spread over a period of several years.

2. Picnic Grounds and Smaller Picnic Sites

While recreation requirements in the crowded London district are the most urgent in the watershed, there is also a definite need for the acquisition for public recreation of additional areas near the other population centres. The Authority has already taken a lead in this work. In the process of making the new river channel at Ingersoll, it was found necessary to acquire a considerable area on both sides of the channel. The Authority prepared plans for the development of two areas as parks. These areas will have a total frontage on the channel of more than 2,000 feet. Much of the land involved requires grading and filling, which can be carried out as fill becomes available from the nearby quarries.

Two small sections of one acre and a quarter of an acre are scheduled for immediate development, the remainder for future development.

Improvement of rural sites can be carried out with little expense. The most essential improvement is the provision of parking space off the roads. For large picnic sites, fireplaces and tables with benches are an advantage. Where a picnic ground will be heavily used, one of the modern designs of small iron fireboxes which can be bought in quantity should be used. These take up little space and use a minimum of fuel. The repetition of many large cemented fireplaces close together is not justified. Receptacles for trash disposal should be fly-proof and also inoffensive to the eye. Shade is of prime importance in picnic sites in Southern Ontario. Tree-planting should therefore be a part of the program for development of any picnic site.

Of several hundred possible picnic sites examined in the watershed, 22 of the best were selected. Their locations are marked on the Recreation Map of the watershed with the same site numbers used in the following list. All are accessible by road. With one or two exceptions which are noted, the area involved would be very small, varying from half an acre to two or three acres.

Picnic Sites Suitable for Acquisition

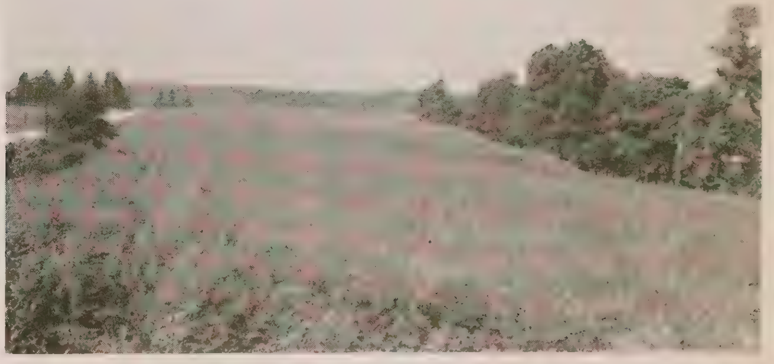
(1) Logan Township, Con. VI, Lot 21 An attractive woodlot on the bank of a small clear stream.

(2) Fullarton Township, Con. IX, Lot 10 This site lies in a valley on a small clear creek.

(3) Fullarton Township, Mitchell Road East Lot 31 A spacious site on the north branch of the Thames close to some of the best bass fishing in the river.

An area recommended for acquisition as a public picnic site. This lies on the Thames River just east of the bridge south of Komoka. The site is on a good road about a mile from Provincial Highway No. 2. This site should be planted with a few shade trees as early as possible.

This land, included in the area described above, would be used for car parking.



On No. 7 Highway, near St. Marys, this roadside picnic site has been set up by the Ontario Department of Highways. The neat arrangement of facilities is an indication to the public to keep the area clean and tidy.

(4) Easthope North Township, Con. I, Lots 40 and 41 A small area one-half mile north of No. 7 Highway on a clear stream. Tree-planting is needed.

(5) Blanshard Township, T.R.C., Lot 42 This is a very attractive picnic area. A ford in the North Branch, approached by a blind road. This is already a very popular site. Space for turning a car around and some tree-planting are needed.

(6) Downie Township, Con. IX, Lot 5 A large and popular picnic site with excellent flats and trees and including a rather muddy swimming hole.

(7) Zorra West Township, Con. II, Lot 30 The site of Harrington Pond. This would be a very attractive site if the old mill dam were restored.

(8) Nissouri West, Con. II, Lot 28
(9) Nissouri West, Con. II, Lot 26
(10) Nissouri West, Con. II, Lots 20 and 21

These three sites all lie in the part of the valley of the North Branch recommended as a possible extension of the Thames Valley Park.

(11) London Township, Con. VII, Lot 18 This is a large and popular area for picnics on Medway Creek. It has several swimming holes and excellent flats on both sides of the road.

(12) London Township, Con. IV, Lot 12 A large area already popular, with stony beaches and some swimming available. It is at the end of a blind road. Some tree-planting is urgently needed.

(13) <u>London Township, Con. III, Lot 29</u> An excellent upland picnic area, with fine views of the Thames Valley.

(14) <u>Delaware Township</u> one-half mile east of Komoka Bridge. This area comprises four acres of rolling non-arable land on the south bank of the Thames River. It lies within an area recommended for reforestation. There are grassed flats at the west end. This kind of recreation site was selected in spite of the absence of trees on it. It should be acquired for its future value. A parking area and immediate tree-planting are needed.

(15) <u>Nissouri East, Con.XII, Lots 5 and 6</u> This excellent park and picnic site, two miles north of Thamesford on the Middle Branch, is strongly recommended for acquisition, but it has one disadvantage, in that it lies in one of the proposed storage basins recommended for flood control purposes in the Hydraulics section of this report. If a decision is made by the Authority to use the area above Thamesford as a flood storage basin the site could not be used.

(16) <u>Oxford North, Con. V, Lot 19, at the Thames River</u>

(17) <u>Dorchester North, Con. B, Lot 7 at the Thames River</u>

These two sites lie a short distance apart on either side of the South Branch of the Thames. Both are approached by blind roads and have attractive flats and terraces. The site in Dorchester North Township is closer to a good highway, but access to it involves crossing a small boggy stream. A small culvert is therefore needed.

(18) Dorchester North, Con. I, Lot 4 The site is on Reynold's Creek. Some trees are present. Additional planting would improve the appearance.

(19) Zorra West Township, Con. V, Lot 13 This site is on the one remaining pond a quarter mile north of Embro.

(20) Zorra East Township, Con. XIV, Lot 29 There are no outstanding sites in this part of the watershed. The one here listed appeared the best available. There is a good but rather muddy swimming hole at the site.

(21) Innerkip Quarry Innerkip Pond, a former quarry, provides a very fine swimming pool. It should be possible to refill a small corner of the quarry with some of the material now lying around the edges, to provide a safe area of shallow water for children. Immediate tree-planting is needed.

(22) Delaware Township, Con. IV, Lot 2 This is a site already very popular for corn roasts. There are excellent flats and fine views from the heights north and south of the site.

3. Swimming Holes

At several points on the river swimming holes have existed for many years. These are frequently found at larger bridges where material has been removed to make the bridge approaches or where the stream cuts sharply around a curve. These old swimming holes are part of a long-established pattern of rural life in Ontario. Very little improvement is needed on many of them, but here and there a diving-board might be included and some indication

The old quarry at St. Marys has been acquired by the town. Facilities such as diving-boards, a raft and a refreshment booth have made this a very popular swimming pool.

This attractive pool two miles north of Woodstock is in the middle of a farming district, and is used by many young people in the neighbourhood.

A historic relic, the old mill wheel at Kilworth still remains. It is in urgent need of repairs. As far as is known, there are no mills with this type of wheel now operating in Ontario.

given as to the depth of water. Some of the existing areas and others which might be established could be included in those of the recommended picnic sites selected for acquisition.

4. <u>Wilderness Areas</u>

It is of great interest both to the general public and to naturalists to retain in every region a small section of country as nearly as possible in its primeval condition. There are few if any such areas in the watershed. Most of the woodlands have been cut over at least once, and many of them have also been burned.

The Ellice Huckleberry Swamp in Ellice Township is no longer of much interest. It has been repeatedly burned since drains were put through it to make the edges usable for agriculture. It has significance for future reforestation and flood control, and might be developed for wildlife, but is of little interest to the general public.

The woods surrounding Hodges Pond in Concession IV, Lots 18 to 21, of Oxford Township have survived much cutting, and probably fires, in fair condition. The area is already a game preserve. The fact that the City of Woodstock derives much of its water from a reservoir in the western edge of the woods is an additional reason for preserving them. Some consideration should be given to the use of this area as a natural park.

The only other wooded area in the south-eastern part of the watershed that merits consideration for recreation is the Huntingford Woods at Concession XI, Lot 15, in Zorra East Township. This land includes old pastures, steep hardwood slopes, cedar thickets, a permanent stream and a marsh. It could be developed both as a picnic site and as an area with a wide range of plant and animal life,

available for field study by urban and rural school systems. Some cutting is now going on in the wooded area.

5. <u>Historic Sites</u>

One historic site might well be made into a public park. This is the site of the old mill at Kilworth in Lobo Township, where a large wooden mill wheel which is probably more than a hundred years old still remains. There is now no sign of the buildings, but there was a mill here at least as early as 1819. The wheel urgently needs repairs. The sites of two of the earliest mills are of greater historic interest, but provide no interesting remnants of the former structures or equipment. One of these is the site of James Burdick's mill, one of the first two grist mills in the watershed, located at Lot 15 B.F., Oxford West Township. This mill was built before 1799 and burned during the War of 1812. The other is Ebenezer Allen's sawmill, the first sawmill in the watershed, on Dingman Creek, built in 179[illegible].

Public interest in the old canoe routes and trails established by the Indians before land settlement has always been keen. It is therefore recommended that a cairn or marker be installed close to the termination of the Indian trail from the head of Lake Ontario to the Thames River. The confluence of the Thames and Cedar Creek was then called the Upper Forks of the Thames and the actual trail end was at a point on Cedar Creek in the vicinity of Woodstock.

6. <u>Conservation Trail</u>

Public interest in conservation is rapidly growing. The subject is already being discussed and taught in both primary and secondary schools. Many enquiries have already been made for help in organizing tours on which good examples may be seen of sound conservation methods in use. Such tours would be a very valuable addition to class-

room teaching. Examples of all phases of conservation could be shown. These should include the results of misuse of land as well as corrective measures.

It is therefore recommended that a Conservation Trail be established in the watershed. Permanent markers could be set up alongside the examples of good land use. Those marking misuse of land would be set up only if the farm was abandoned. An outline and map of the tour could be mimeographed for distribution to all students or visitors taking part in it. The route should be approximately a circle and should include several attractive picnic sites so that parties from widely separated schools could cut in on the route at various points and still have suitable areas for lunch.